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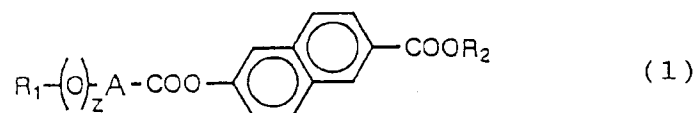
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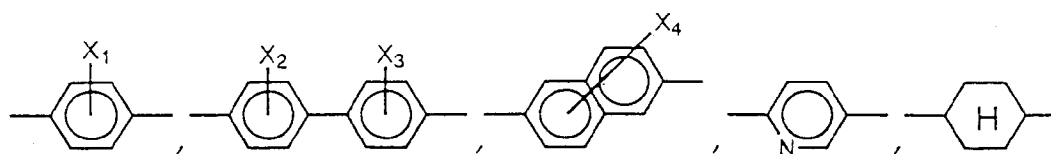
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(54) Naphthalene compound, and liquid crystal composition and liquid crystal element using the same

(57) Provided is a naphthalene compound represented by the following Formula (1):



wherein R_1 and R_2 each represent a linear or branched alkyl group having 1 to 20 carbon atoms, an alkoxyalkyl group having 2 to 20 carbon atoms or an alkenyl group having 2 to 20 carbon atoms which may be substituted with halogen atoms and have no asymmetric carbon atoms; A represents any of the groups represented by the following formulas:



(wherein X_1 , X_2 , X_3 and X_4 each represent a hydrogen atom or a halogen atom); and z represents 0 or 1. The addition of this naphthalene compound to a liquid crystal composition makes it possible to improve various characteristics such as the high speed response property of the liquid crystal composition and the temperature dependency of the response time. The above naphthalene compound is useful as a liquid crystal material for liquid crystal compositions, particularly ferroelectric liquid crystal compositions.

Description

The present invention relates to naphthalene compounds, liquid crystal compositions containing naphthalene compounds, and a liquid crystal element using such a liquid crystal composition.

Liquid crystal display elements have so far widely been used for various display elements by making the best use of excellent characteristics thereof such as low voltage actuation, low power consumption, possibility of thin type display, and no fatigue of eyes because of light-receptive display element.

Among them, there have widely been used TN (twisted nematic) type liquid crystal display elements using nematic liquid crystal and STN (super twisted nematic) type liquid crystal display elements having a torsion angle adjusted to 180 to 270°. These display elements are nematic liquid crystal display elements using nematic liquid crystal. These nematic liquid crystal display elements have the defect that they have a long response time and therefore can provide only a response time falling in an order of some ten msec.

A recent progress in industrial techniques has been followed by strong requirement of high speed response to liquid crystal elements, and in order to meet such requirement, various attempts have been made by improving liquid crystal materials. For example, a display device making use of a photoswitching phenomenon of ferroelectric liquid crystal has been proposed [Appl. Phys. Lett., 36, 899 (1980)]. The liquid crystal elements are expected to be applied to not only displays for liquid crystal televisions, etc., but also to materials for optoelectronics-related elements such as optical printer heads, optical Fourier transform elements and light valves.

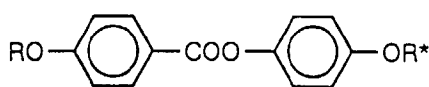
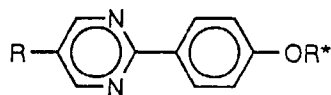
Ferroelectric liquid crystals belong to tilt series chiral smectic phases in terms of a liquid crystal phase, and among them, liquid crystal phase called a chiral smectic C phase having a low viscosity is preferred from a viewpoint of practical use. Various liquid crystal compounds showing chiral smectic C phases have so far been investigated, and a lot of compounds have already been found and produced. Conditions for using them for ferroelectric liquid crystal elements include:

- showing a chiral smectic C phase in a wide temperature range including room temperature,
- having a suitable phase series on a high temperature part of a chiral smectic C phase and large helical pitches thereof in order to obtain good orientation,
- having a suitable tilt angle,
- having a low viscosity,
- having spontaneous polarization which is large to some extent, and the like.

No single ferroelectric liquid crystal which can satisfy these conditions has ever been known. Accordingly, ferroelectric liquid crystal compositions obtained by blending several liquid crystal compounds or non-liquid crystal compounds have to be used in practical uses.

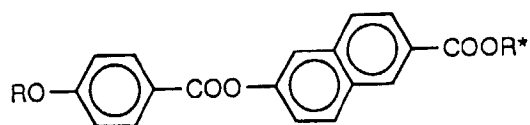
A ferroelectric liquid crystal composition does not always comprise only ferroelectric liquid crystal compounds, and it is disclosed in, for example, Japanese Patent Application Laid-Open No. 60-36003 (1985) that compositions showing ferroelectric liquid crystal phases as a whole can be obtained by employing compounds or compositions showing non-chiral smectic C, F, G, H and I phases for fundamental materials and blending them with one or plural compounds showing ferroelectric liquid crystal phases. Further, it is reported that ferroelectric liquid crystal compositions can be obtained as a whole by employing compounds or compositions showing phases such as a non-chiral smectic C phase for fundamental materials and blending them with one or plural compounds which are optically active but do not show ferroelectric liquid crystal phases [Mol. Cryst. Liq. Cryst., 89, 327 (1982)].

Phenylpyrimidine series liquid crystal compounds and phenylbenzoate series liquid crystal compounds as shown below have so far been known as typical compounds showing chiral smectic C phases:



wherein R represents an alkyl group, and R* represents an optically active alkyl group.

Further, naphthalene series liquid crystal compounds as shown below are proposed in Japanese Patent Application Laid-open No. 63-246346 (1988), Japanese Patent Application Laid-open No. 1-193390 (1989), Japanese Patent Application Laid-open No. 3-68686 (1991) and Japanese Patent Application Laid-open No. 3-106850 (1991):

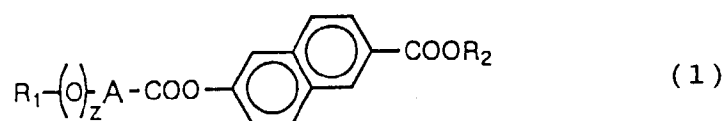


wherein R represents an alkyl group, and R* represents an optically active alkyl group.

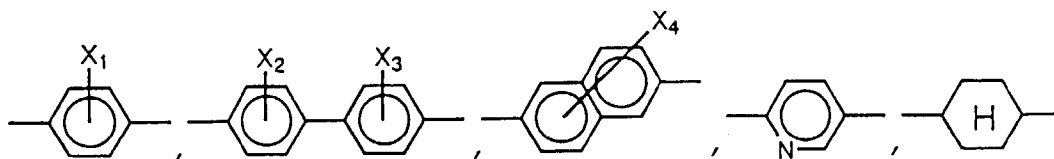
However, ferroelectric liquid crystal compositions using the phenylpyrimidine series liquid crystal compounds or phenylbenzoate series liquid crystal compounds described above have had the problems that they are liable to cause orientation unevenness so as to bring about defects when they are put into liquid crystal cells and that the good memory property can not be obtained and the contrast ratio is low. Meanwhile, ferroelectric liquid crystal compositions comprising the naphthalene series compounds described above show good orientation when liquid crystal cells are charged with them, and can provide a good memory property without having defects. However, it is not reasonable to say that they have sufficiently satisfactory characteristics in terms of high speed response and temperature dependency of a response time.

Preferred embodiments of the invention may provide liquid crystal compounds suited to improve such various characteristics as high speed response, orientation and high contrast ratio when the liquid crystal compound is blended into a ferroelectric liquid crystal composition in order to put a ferroelectric liquid crystal element into practical use, a compound useful as a component for a liquid crystal composition, an intermediate product for producing the above compound and a liquid crystal composition containing the above compound, and a liquid crystal element using said liquid crystal composition.

First, the present invention relates to a naphthalene compound represented by the following Formula (1):

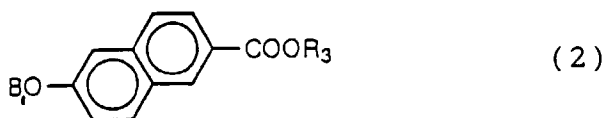


wherein R₁ and R₂ each represent a linear or branched alkyl group having 1 to 20 carbon atoms, an alkoxyalkyl group having 2 to 20 carbon atoms or an alkenyl group having 2 to 20 carbon atoms which may be substituted with halogen atoms and have no asymmetric carbon atoms; A represents any of the groups represented by the following formulas:



(wherein X₁, X₂, X₃ and X₄ each represent a hydrogen atom or a halogen atom, and 1,4-cyclohexylene ring is disposed in a trans position); and z represents 0 or 1.

Further, the present invention relates to a naphthalene compound represented by the following Formula (2) which is useful as an intermediate product when producing the naphthalene compound represented by Formula (1):



wherein R_3 represents a branched alkyl group having no asymmetric carbon atoms and having 3 to 20 carbon atoms, or a linear or branched alkyl group having 1 to 20 carbon atoms, an alkoxyalkyl group having 2 to 20 carbon atoms or an alkenyl group having 2 to 20 carbon atoms which are substituted with halogen atoms and have no asymmetric carbon atoms; and B_1 represents a hydrogen atom or a benzyl group.

Furthermore, the present invention relates to a liquid crystal composition using the compound represented by Formula (1), and a liquid crystal element using said liquid crystal composition.

The liquid crystal composition using the naphthalene compound of the preferred embodiments is improved in various characteristics such as high speed response, temperature dependency of a response time, etc.

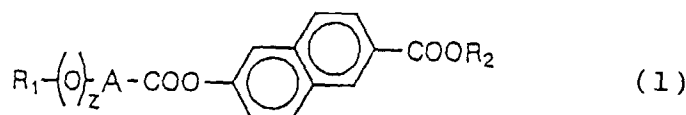
Some embodiments of the invention will now be described with reference to the accompanying drawings in which:

Fig. 1 is a schematic, cross-sectional view of one example of a liquid crystal element using a liquid crystal showing a chiral smectic phase.

Fig. 2 is a graph showing the temperature dependency of the response time of the liquid crystal compositions of Examples 115 and 116 and the comparative example.

The present invention will be explained below in detail.

The naphthalene compound of the present invention represented by Formula (1) is a novel compound.



In Formula (1), R_1 and R_2 each represent a linear or branched alkyl group having 1 to 20 carbon atoms, an alkoxyalkyl group having 2 to 20 carbon atoms or an alkenyl group having 2 to 20 carbon atoms which may be substituted with halogen atoms and have no asymmetric carbon atoms. More preferably, R_1 and R_2 each represent a linear or branched alkyl group represented by Formulas (I) and (II):



(wherein a represents a natural number of 1 to 20; b represents a natural number of 0 to 17; and c represents a natural number of 1 to 9, provided that $b + (c \times 2) \leq 19$), an alkoxyalkyl group represented by Formula (III):



(wherein d represents a natural number of 1 to 10; e represents a natural number of 1 to 10; f represents a natural number of 0 to 5; and g represents a natural number of 1 to 12, provided that $d + e \times f + g \leq 20$), or a halogenated alkyl group represented by Formula (IV), (V) or (VI):





(wherein X represents a halogen atom; h represents a natural number of 0 to 19; i represents a natural number of 1 to 20; j represents a natural number of 0 to 18; k represents a natural number of 1 to 10; l represents a natural number of 1 to 19; and m represents a natural number of 1 to 19; n represents a natural number of 0 to 19; p represents a natural number of 1 to 20, provided that $h + i \leq 20$, $j + k \times l + m < 20$ and $n + p \leq 20$).

More preferably, R_1 and R_2 each represent the group represented by Formula (I), (II), (III), (IV) or (VI).

Further preferably, R_1 represents the group represented by Formula (I), (III), (IV) or (VI).

The concrete examples of the groups represented by R_1 and R_2 include linear alkyl groups such as methyl, ethyl, n-propyl, n-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, n-nonyl, n-decyl, n-undecyl, n-dodecyl, n-tridecyl, n-tetradecyl, n-pentadecyl, n-hexadecyl, n-heptadecyl, n-octadecyl, n-nonadecyl and n-eicocyl,

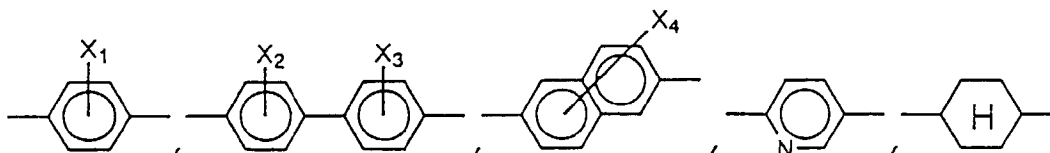
branched alkyl groups such as 1-methylethyl, 2-methylpropyl, 3-methylbutyl, 4-methylpentyl, 5-methylhexyl, 6-methylheptyl, 7-methyloctyl, 8-methylnonyl, 9-methyldecyl, 11-methyldodecyl, 3-pentyl, 2-ethylbutyl, 3-ethylpentyl, 4-ethylhexyl, 5-ethylheptyl, 6-ethyloctyl, 4-heptyl, 2-n-propylpentyl, 3-n-propylhexyl, 4-n-propylheptyl, 5-n-propyloctyl, 6-n-propylnonyl, 7-n-propyldecyl, 8-n-propylundecyl, 9-n-propyldodecyl, 1-n-butylpentyl, 2-n-butylhexyl, 3-n-butylheptyl, 4-n-butyloctyl, 5-n-butyl-nonyl, 6-n-butyldecyl, 7-n-butylundecyl, 8-n-butyl-dodecyl, 2-n-pentylheptyl, 3-n-pentyloctyl, 5-n-pentyldecyl, 3-n-hexylnonyl, 4-n-hexyldecyl, 6-n-hexyldodecyl, 2,2-dimethylpropyl, 2,2-dimethylbutyl, 3,3-dimethylbutyl, 3,3-dimethylpentyl, 4,4-dimethylpentyl, 5,5-dimethylhexyl, 6,6-dimethylheptyl, 3,3-diethylpentyl and 2,2,4,4-tetramethylpentyl,

halogenated alkyl groups such as fluoromethyl, difluoromethyl, 2-fluoroethyl, 3-fluoro-n-propyl, 4-fluoro-n-butyl, 5-fluoro-n-pentyl, 6-fluoro-n-hexyl, 2-chloroethyl, 3-chloro-n-propyl, 4-chloro-n-butyl, 5-chloro-n-pentyl, trifluoromethyl, perfluoroethyl, perfluoro-n-propyl, perfluoroisopropyl, perfluoro-n-butyl, perfluoroisobutyl, perfluoro-n-pentyl, perfluoroisopentyl, perfluoro-n-hexyl, perfluoro-n-heptyl, perfluoro-n-octyl, perfluoro-n-nonyl, perfluoro-n-decyl, perfluoro-n-undecyl, perfluoro-n-dodecyl, perfluoro-n-tetradecyl, 1-hydroperfluoroisopropyl, 1,1-dihydroperfluoroethyl, 1,1-dihydroperfluoro-n-propyl, 1,1-dihydroperfluoro-n-butyl, 1,1-dihydroperfluoroisobutyl, 1,1-dihydroperfluoro-n-pentyl, 1,1-dihydroperfluoro-n-hexyl, 1,1-dihydroperfluoro-n-heptyl, 1,1-dihydroperfluoro-n-octyl, 1,1-dihydroperfluoro-n-nonyl, 1,1-dihydroperfluoro-n-decyl, 1,1-dihydroperfluoro-n-undecyl, 1,1-dihydroperfluoro-n-dodecyl, 1,1-dihydroperfluoro-n-tetradecyl, 1,1-dihydroperfluoro-n-pentadecyl, 1,1-dihydroperfluoro-n-hexadecyl, 1,1,2-trihydroperfluoroethyl, 1,1,3-trihydroperfluoro-n-propyl, 1,1,4-trihydroperfluoro-n-butyl, 1,1,5-trihydroperfluoro-n-pentyl, 1,1,6-trihydroperfluoro-n-hexyl, 1,1,7-trihydroperfluoro-n-heptyl, 1,1,8-trihydroperfluoro-n-octyl, 1,1,9-trihydroperfluoro-n-nonyl, 1,1,11-trihydroperfluoro-n-undecyl, 2-(perfluoroethyl)ethyl, 2-(perfluoro-n-propyl)ethyl, 2-(perfluoro-n-butyl)ethyl, 2-(perfluoro-n-pentyl)ethyl, 2-(perfluoro-3-methylbutyl)ethyl, 2-(perfluoro-n-hexyl)ethyl, 2-(perfluoro-n-heptyl)ethyl, 2-(perfluoro-5-methylhexyl)ethyl, 2-(perfluoro-n-octyl)ethyl, 2-(perfluoro-7-methyloctyl)ethyl, 2-(perfluoro-n-decyl)ethyl, 2-(perfluoro-n-nonyl)ethyl, 2-(perfluoro-9-methyldecyl)ethyl, 2-(perfluoro-n-dodecyl)ethyl, 2,2-bis(trifluoromethyl)propyl, 3-(perfluoro-n-propyl)-n-propyl, 3-(perfluoro-n-butyl)-n-propyl, 3-(perfluoro-n-hexyl)-n-propyl, 3-(perfluoro-n-heptyl)-n-propyl, 3-(perfluoro-n-octyl)-n-propyl, 3-(perfluoro-n-decyl)-n-propyl, 3-(perfluoro-n-dodecyl)-n-propyl, 4-(perfluoroethyl)-n-butyl, 4-(perfluoro-n-propyl)-n-butyl, 4-(perfluoro-n-butyl)-n-butyl, 4-(perfluoro-n-pentyl)-n-butyl, 4-(perfluoro-n-hexyl)-n-butyl, 4-(perfluoro-n-heptyl)-n-butyl, 4-(perfluoro-n-octyl)-n-butyl, 4-(perfluoro-n-decyl)-n-butyl, 5-(perfluoro-n-propyl)-n-pentyl, 5-(perfluoro-n-butyl)-n-pentyl, 5-(perfluoro-n-pentyl)-n-pentyl, 5-(perfluoro-n-hexyl)-n-pentyl, 5-(perfluoro-n-heptyl)-n-pentyl, 5-(perfluoro-n-octyl)-n-pentyl, 6-(perfluoroethyl)-n-hexyl, 6-(perfluoro-n-propyl)-n-hexyl, 6-(perfluoro-1-methylethyl)-n-hexyl, 6-(perfluoro-n-butyl)-n-hexyl, 6-(perfluoro-n-hexyl)-n-hexyl, 6-(perfluoro-n-heptyl)-n-hexyl, 6-(perfluoro-5-methylhexyl)-n-hexyl, 6-(perfluoro-n-octyl)-n-hexyl, 6-(perfluoro-7-methyloctyl)-n-hexyl, 7-(perfluoroethyl)-n-heptyl, 7-(perfluoro-n-propyl)-n-heptyl, 7-(perfluoro-n-butyl)-n-heptyl and 7-(perfluoro-n-pentyl)-n-heptyl, alkoxyalkyl groups such as methoxymethyl, 2-methoxyethyl, 3-methoxypropyl, 4-methoxybutyl, 5-methoxypentyl, 6-methoxyhexyl, 7-methoxyheptyl, 8-methoxyoctyl, 9-methoxynonyl, 10-methoxydecyl, ethoxymethyl, 2-ethoxyethyl, 3-ethoxypropyl, 4-ethoxybutyl, 5-ethoxypentyl, 6-ethoxyhexyl, 7-ethoxyheptyl, 8-ethoxyoctyl, 9-ethoxynonyl, 10-ethoxydecyl, n-propoxymethyl, 2-n-propoxyethyl, 3-n-propoxypropyl, 4-n-propoxybutyl, 5-n-propoxypentyl, 6-n-propoxyhexyl, 7-n-propoxyheptyl, 8-n-propoxyoctyl, 9-n-propoxynonyl, 10-n-propoxydecyl, n-butoxymethyl, 2-n-butoxyethyl, 3-n-butoxypropyl, 4-n-butoxybutyl, 5-n-butoxypentyl, 6-n-butoxyhexyl, 7-n-butoxyheptyl, 8-n-butoxyoctyl, 9-n-butoxynonyl, 10-n-butoxydecyl, n-pentyloxymethyl, 2-n-pentyloxyethyl, 3-n-pentyloxypropyl, 4-n-pentyloxybutyl, 5-n-pentyloxypentyl, 6-n-pentyloxyhexyl, 7-n-pentyloxyheptyl, 8-n-pentyloxyoctyl, 9-n-pentyloxynonyl, 10-n-pentyloxydecyl, n-hexyloxymethyl, 2-n-hexyloxyethyl, 3-n-hexyloxypropyl, 4-n-hexyloxybutyl, 5-n-hexyloxypentyl, 6-n-hexyloxyhexyl, 7-n-hexyloxyheptyl, 8-n-hexyloxyoctyl, 9-n-hexyloxynonyl, 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10-n-nonadecylloxydecyl, n-eicocylloxymethyl, 2-n-eicocylloxyethyl, 3-n-eicocylloxypropyl, 4-n-eicocylloxybutyl, 5-n-eicocylloxypentyl, 6-n-eicocylloxyhexyl, 7-n-eicocylloxyheptyl, 8-n-eicocylloxyoctyl, 9-n-eicocylloxynonyl, 10-n-eicocylloxydecyl.

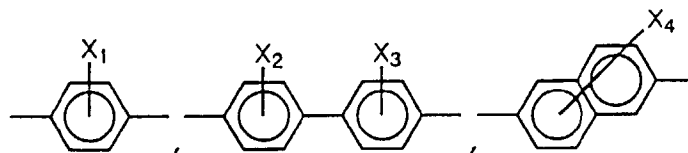
tyl, 9-n-octyloxynonyl, 10-n-octyloxydecyl, n-nonyloxymethyl, 2-n-nonyloxyethyl, 3-n-nonyloxypropyl, 4-n-nonyloxybutyl, 5-n-nonyloxypropyl, 6-n-nonyloxyhexyl, 7-n-nonyloxyheptyl, 8-n-nonyloxyoctyl, 9-n-nonyloxydecanyl, 10-n-nonyloxydecyl, n-decyloxymethyl, 2-n-decyloxyethyl, 3-n-decyloxypropyl, 4-n-decyloxybutyl, 5-n-decyloxypropyl, 6-n-decyloxyhexyl, 7-n-decyloxyheptyl, 8-n-decyloxyoctyl, 9-n-decyloxynonyl, 2-n-undecyloxyethyl, 4-n-undecyloxybutyl, 6-n-undecyloxyhexyl, 8-n-undecyloxyoctyl, 2-n-dodecyloxyethyl, 4-n-dodecyloxybutyl, 6-n-dodecyloxyhexyl, isopropoxymethyl, 2-isopropoxyethyl, 3-isopropoxypropyl, 4-isopropoxybutyl, 5-isopropoxypropyl, 6-isopropoxyhexyl, 7-isopropoxyheptyl, 8-isopropoxyoctyl, 9-isopropoxynonyl, 10-isopropoxydecyl, isobutoxymethyl, 2-isobutoxyethyl, 3-isobutoxypropyl, 4-isobutoxybutyl, 5-isobutoxypropyl, 6-isobutoxyhexyl, 7-isobutoxyheptyl, 8-isobutoxyoctyl, 9-isobutoxynonyl, 10-isobutoxydecyl, tert-butoxymethyl, 2-tert-butoxyethyl, 3-tert-butoxypropyl, 4-tert-butoxybutyl, 5-tert-butoxypropyl, 6-tert-butoxyhexyl, 7-tert-butoxyheptyl, 8-tert-butoxyoctyl, 9-tert-butoxynonyl, 10-tert-butoxydecyl, (2-ethylbutoxy)methyl, 2-(2'-ethylbutoxy)ethyl, 3-(2'-ethylbutoxy)propyl, 4-(2'-ethylbutoxy)butyl, 5-(2'-ethylbutoxy)pentyl, 6-(2'-ethylbutoxy)hexyl, 7-(2'-ethylbutoxy)heptyl, 8-(2'-ethylbutoxy)octyl, 9-(2'-ethylbutoxy)nonyl, 10-(2'-ethylbutoxy)decyl, (3-ethylpentyloxy)methyl, 2-(3'-ethylpentyloxy)ethyl, 3-(3'-ethylpentyloxy)propyl, 4-(3'-ethylpentyloxy)butyl, 5-(3'-ethylpentyloxy)pentyl, 6-(3'-ethylpentyloxy)hexyl, 7-(3'-ethylpentyloxy)heptyl, 8-(3'-ethylpentyloxy)octyl, 9-(3'-ethylpentyloxy)nonyl, 10-(3'-ethylpentyloxy)decyl, 2-(2'-methoxyethoxy)ethyl, 2-(2'-ethoxyethoxy)ethyl, 2-(2'-n-propoxyethoxy)ethyl, 2-(2'-isopropoxyethoxy)ethyl, 2-(2'-n-butoxyethoxy)ethyl, 2-(2'-isobutoxyethoxy)ethyl, 2-(2'-tert-butoxyethoxy)ethyl, 2-(2'-n-pentyloxyethoxy)ethyl, 2-[2'-(2"-ethylbutoxy)ethoxy]ethyl, 2-(2'-n-hexyloxyethoxy)ethyl, 2-[2'-(3"-ethylpentyloxy)ethoxy]ethyl, 2-(2'-n-heptyloxyethoxy)ethyl, 2-(2'-n-octyloxyethoxy)ethyl, 2-(2'-n-nonyloxyethoxy)ethyl, 2-(2'-n-decyloxyethoxy)ethyl, 2-(2'-n-undecyloxyethoxy)ethyl, 2-(2'-n-dodecyloxyethoxy)ethyl, 2-[2'-(2"-methoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-ethoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-propoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-isopropoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-butoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-isobutoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-tert-butoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-pentyloxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-hexyloxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-heptyloxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-octyloxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-nonyloxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-decyloxyethoxy)ethoxy]ethyl, 2-[2'-(2"-n-undecyloxyethoxy)ethoxy]ethyl, 2-[2'-(2"-methoxyethoxy)ethoxy]ethyl, 2-[2'-(2"-ethoxyethoxy)ethoxy]ethyl, (2-ethoxyethoxy)methyl, (2-n-butoxyethoxy)methyl, (2-n-hexyloxyethoxy)methyl, (3-ethoxypropoxy)methyl, (3-n-propoxypropoxy)methyl, (3-n-pentyloxypropoxy)methyl, (3-n-hexyloxypropoxy)methyl, (4-methoxybutoxy)methyl, (4-ethoxybutoxy)methyl, (4-n-butoxybutoxy)methyl, 2-(3'-methoxypropoxy)ethyl, 2-(3'-ethoxypropoxy)ethyl, 2-(4'-methoxybutoxy)ethyl, 2-(4'-ethoxybutoxy)ethyl, 2-[4'-(2"-ethylbutoxy)butoxy]ethyl, 2-[4'-(3"-ethylpentyloxy)butoxy]ethyl, 3-(2'-methoxyethoxy)propyl, 3-(2'-ethoxyethoxy)propyl, 3-(2'-n-pentyloxyethoxy)propyl, 3-(2'-n-hexyloxyethoxy)propyl, 3-(3'-ethoxypropoxy)propyl, 3-(3'-n-propoxypropoxy)propyl, 3-(3'-n-butoxypropoxy)propyl, 3-(4'-ethoxybutoxy)propyl, 3-(5'-ethoxypropoxy)propyl, 4-(2'-methoxyethoxy)butyl, 4-(2'-ethoxyethoxy)butyl, 4-(2'-isopropoxyethoxy)butyl, 4-(2'-isobutoxyethoxy)butyl, 4-(2'-n-butoxyethoxy)butyl, 4-(2'-n-hexyloxyethoxy)butyl, 4-(3'-n-propoxypropoxy)butyl, 4-[2'-(2"-methoxyethoxy)ethoxy]butyl, 4-[2'-(2"-n-butoxyethoxy)ethoxy]butyl and 4-[2'-(2"-n-hexyloxyethoxy)ethoxy]butyl,

halogenated alkoxyalkyl groups such as 2-(2'-fluoroethoxy)ethyl, 4-(2'-fluoroethoxy)butyl, 6-(2'-fluoroethoxy)hexyl, 8-(2'-fluoroethoxy)octyl, 2-(3'-fluoro-n-propoxy)ethyl, 4-(3'-fluoro-n-propoxy)butyl, 6-(3'-fluoro-n-propoxy)hexyl, 8-(3'-fluoro-n-propoxy)octyl, 2-(4'-fluoro-n-butoxy)ethyl, 4-(4'-fluoro-n-butoxy)butyl, 6-(4'-fluoro-n-butoxy)hexyl, 8-(4'-fluoro-n-butoxy)octyl, 2-(2'-chloroethoxy)ethyl, 4-(2'-chloroethoxy)butyl, 6-(2'-chloroethoxy)hexyl, 8-(2'-chloroethoxy)octyl, 2-(3'-chloro-n-propoxy)ethyl, 4-(3'-chloro-n-propoxy)butyl, 6-(3'-chloro-n-propoxy)hexyl, 8-(3'-chloro-n-propoxy)octyl, 2-(4'-chloro-n-butoxy)ethyl, 4-(4'-chloro-n-butoxy)butyl, 6-(4'-chloro-n-butoxy)hexyl and 8-(4'-chloro-n-butoxy)octyl, and alkenyl groups such as vinyl, propenyl, 2-butenyl, 3-butenyl, 3-hexenyl, 5-hexenyl, 2-octenyl, 3-octenyl, 7-octenyl, 2-nonenyl, 3-nonenyl, 6-nonenyl, 8-nonenyl, 2-decenyl, 3-decenyl, 9-decenyl, 2-undecenyl, 3-undecenyl, 10-undecenyl, 2-dodecenyl, 3-dodecenyl, and 11-dodecenyl.

In Formula (1), A represents any of the groups represented by the following formulas:



preferably any of the groups represented by the following formulas:



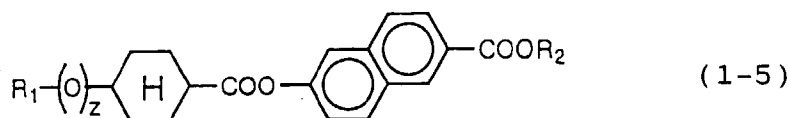
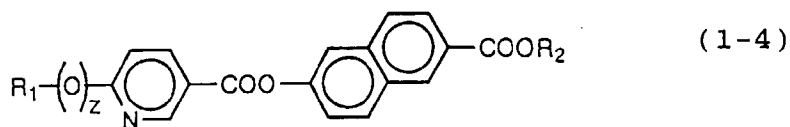
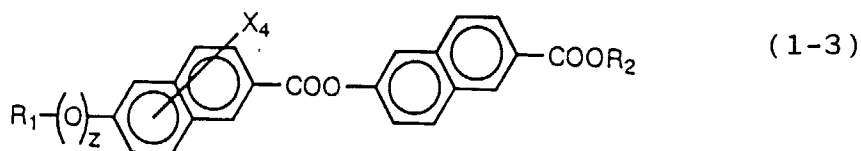
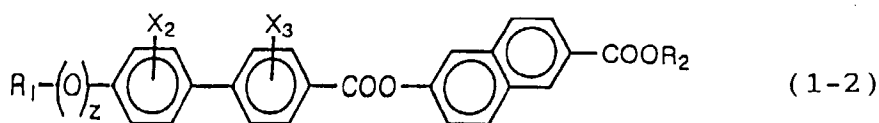
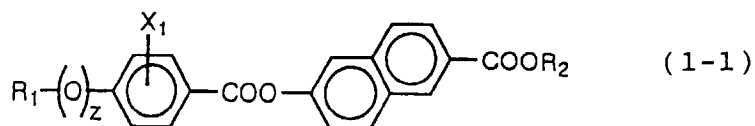
In A, X_1 , X_2 , X_3 and X_4 each represent a hydrogen atom or a halogen atom, preferably a hydrogen atom, a fluorine atom, a chlorine atom or a bromine atom, more preferably a hydrogen atom, a fluorine atom or a chlorine atom, and further preferably a hydrogen atom or a fluorine atom.

The substitution position of X_1 or X_2 is ortho positions or meta positions to the substituent R_1 - or R_1O -, preferably an ortho position. The substitution position of X_3 is an ortho position or a meta position to a $-COO-$ group, preferably an ortho position.

The substitution position of X_4 is an α -position or β -position on the naphthalene ring, preferably an ortho position to the substituent R_1 - or R_1O - and/or a $-COO-$ group, more preferably an ortho position to the substituent R_1 - or R_1O - and/or a $-COO-$ group, and an α -position on the naphthalene ring.

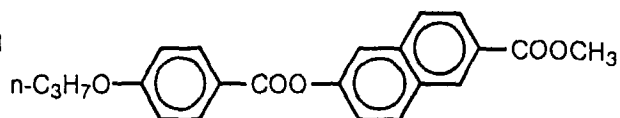
In Formula (1), z represents 0 or 1.

The naphthalene compounds represented by Formula (1) of the present invention are classified broadly into five kinds of the following structures (1-1) to (1-5):

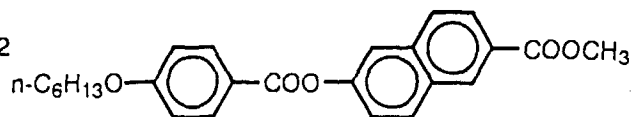


The compounds having the structures shown below can be given as the concrete examples of the naphthalene compound represented by Formula (1):

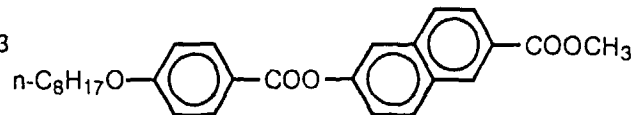
Exemplified compound 1



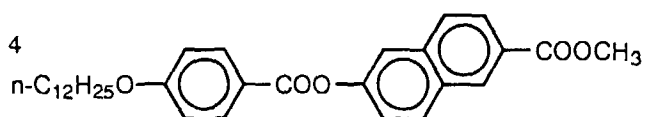
Exemplified compound 2



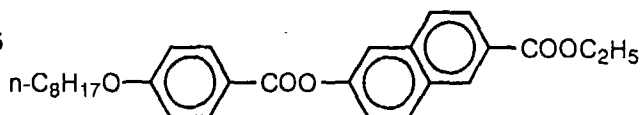
Exemplified compound 3



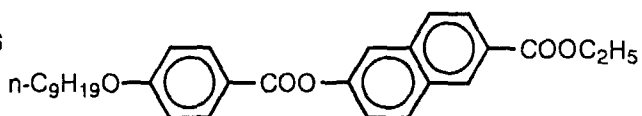
Exemplified compound 4



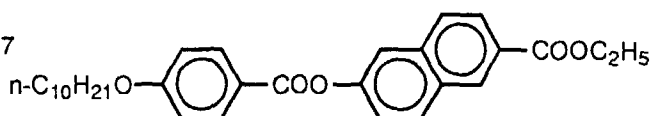
Exemplified compound 5



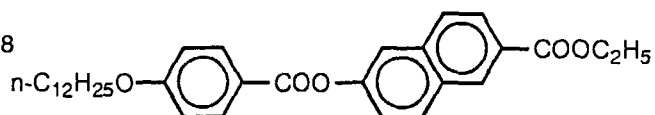
Exemplified compound 6



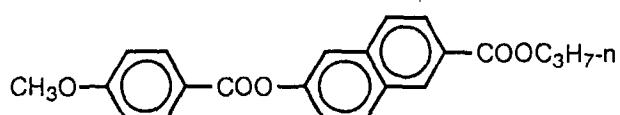
Exemplified compound 7



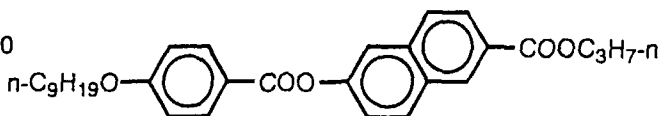
Exemplified compound 8



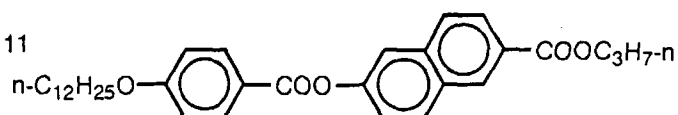
Exemplified compound 9



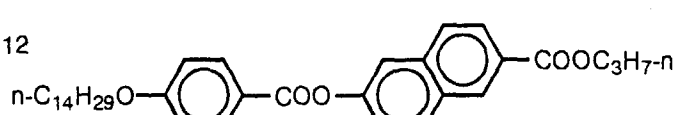
Exemplified compound 10



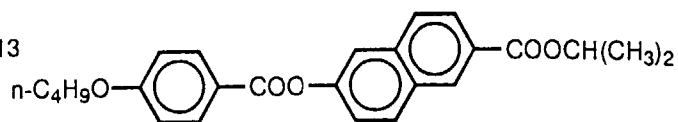
Exemplified compound 11



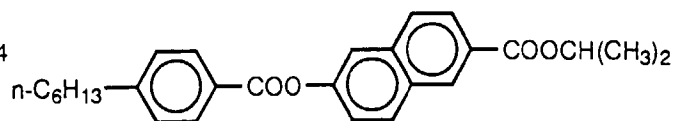
Exemplified compound 12



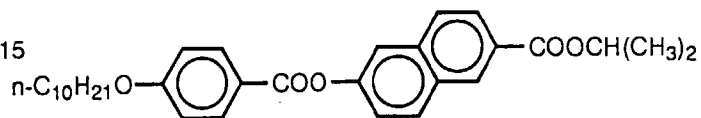
Exemplified compound 13



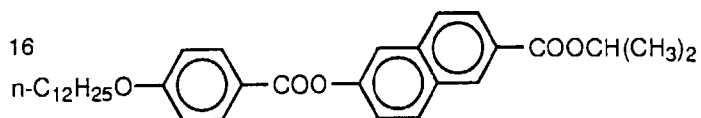
Exemplified compound 14



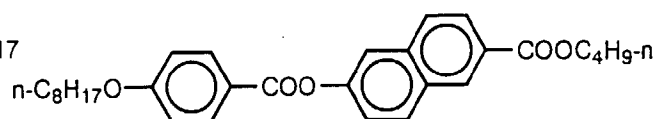
Exemplified compound 15



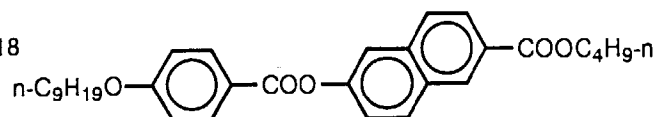
Exemplified compound 16



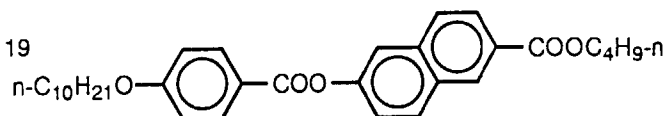
Exemplified compound 17



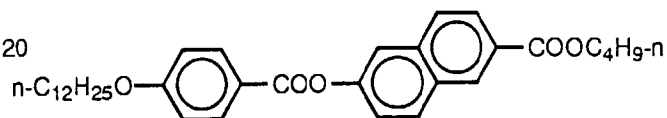
Exemplified compound 18



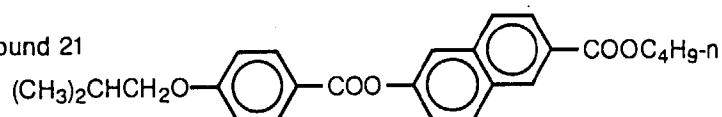
Exemplified compound 19



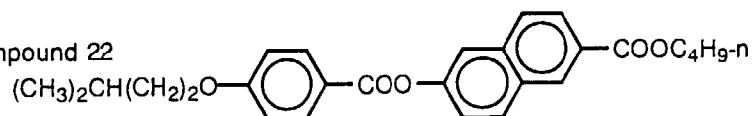
Exemplified compound 20



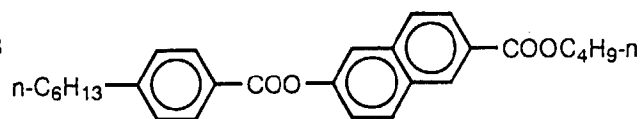
Exemplified compound 21



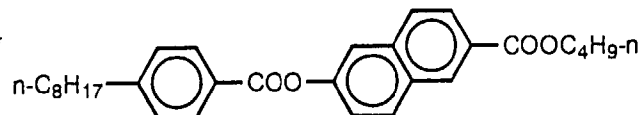
Exemplified compound 22

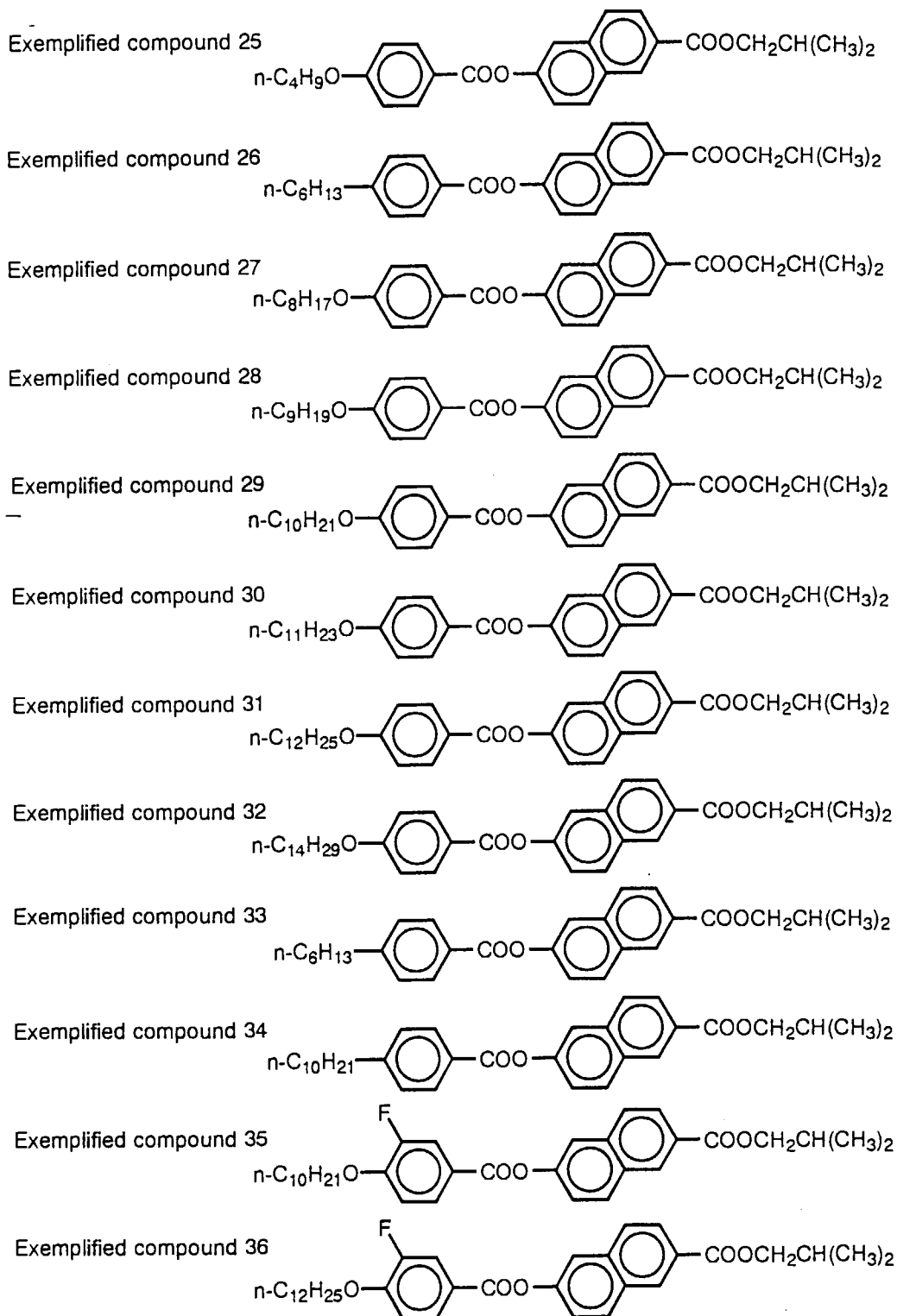


Exemplified compound 23

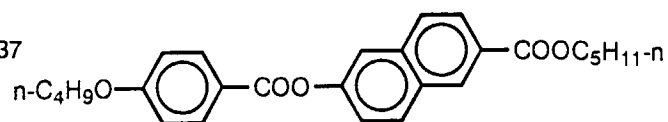


Exemplified compound 24

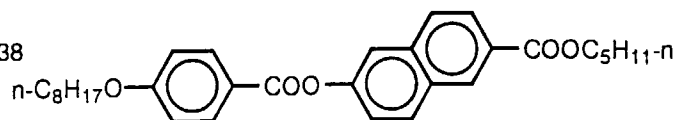




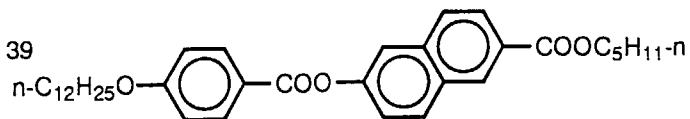
Exemplified compound 37



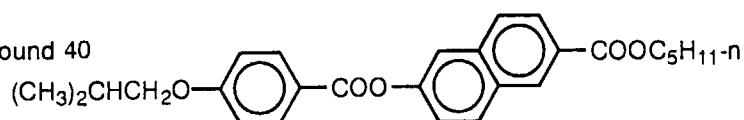
Exemplified compound 38



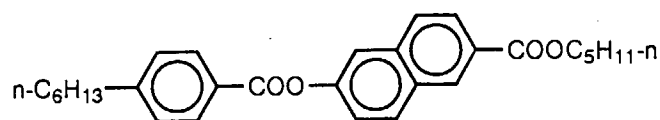
Exemplified compound 39



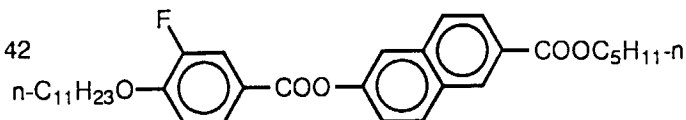
Exemplified compound 40



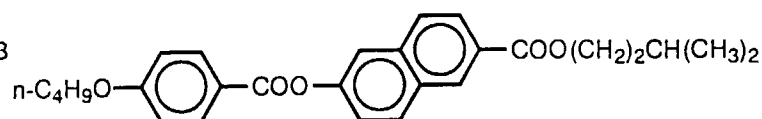
Exemplified compound 41



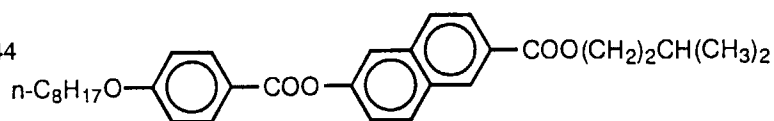
Exemplified compound 42



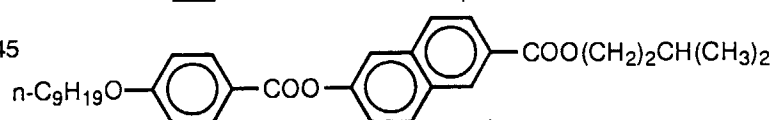
Exemplified compound 43



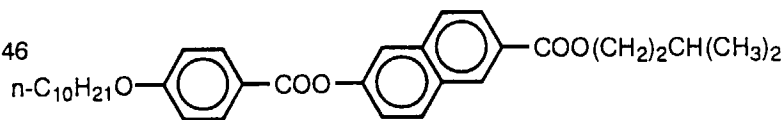
Exemplified compound 44



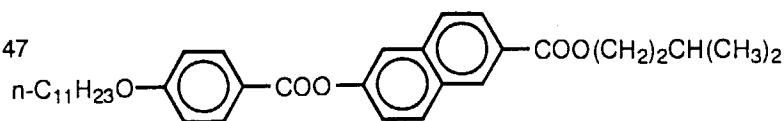
Exemplified compound 45



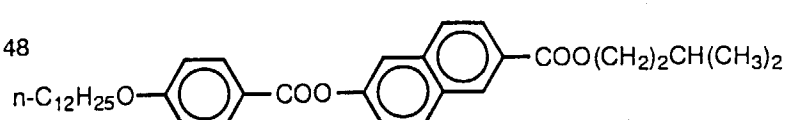
Exemplified compound 46

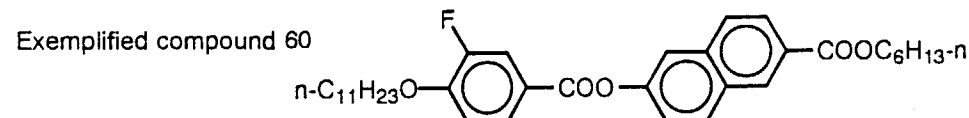
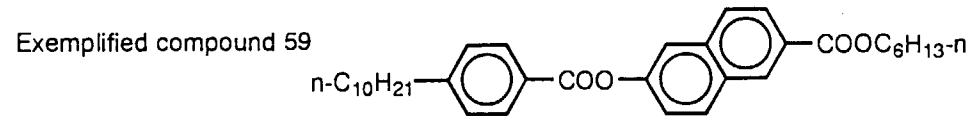
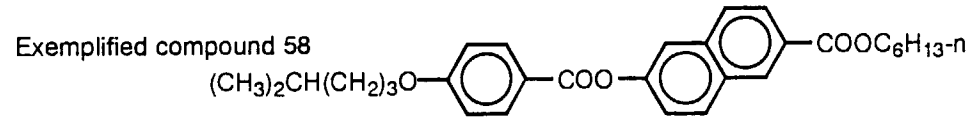
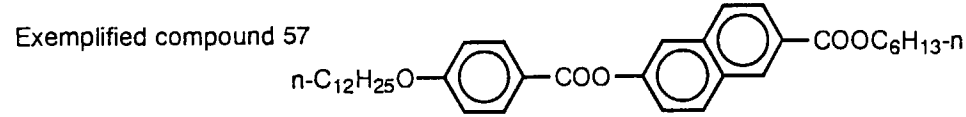
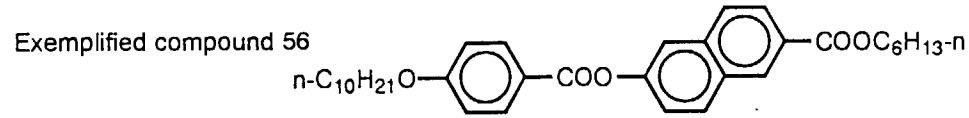
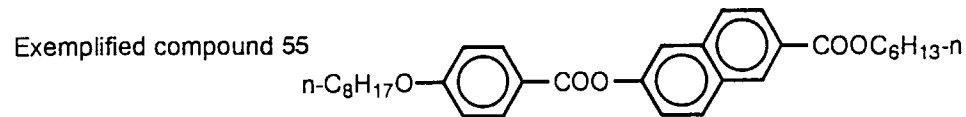
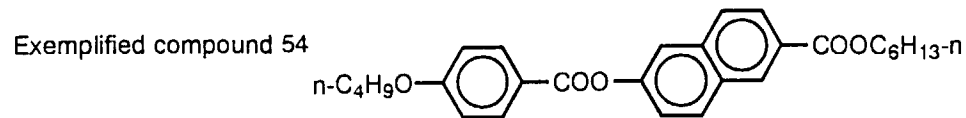
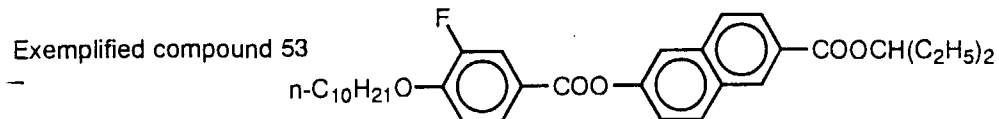
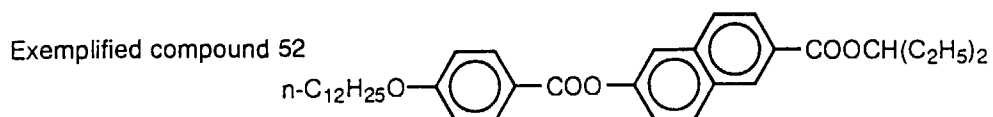
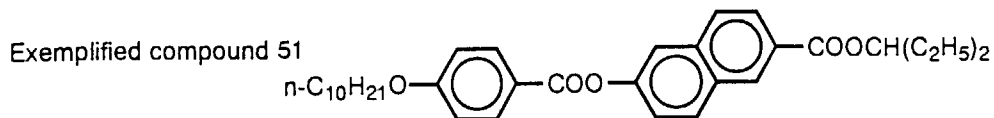
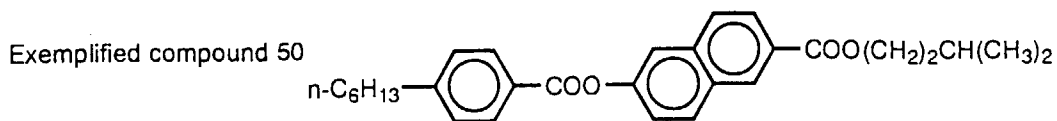
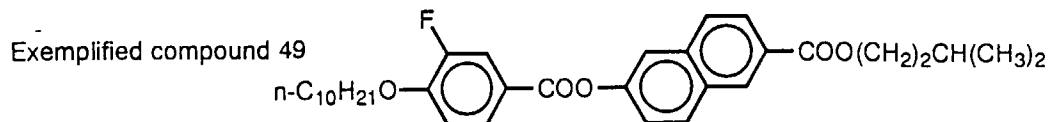


Exemplified compound 47

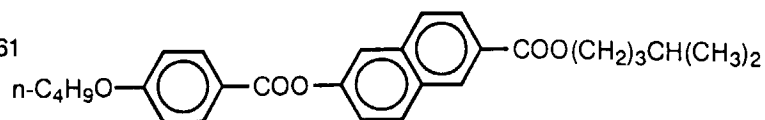


Exemplified compound 48

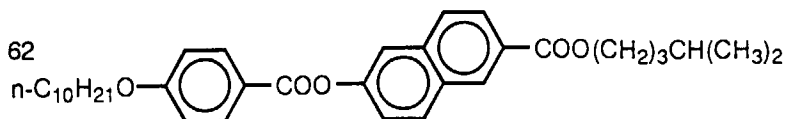




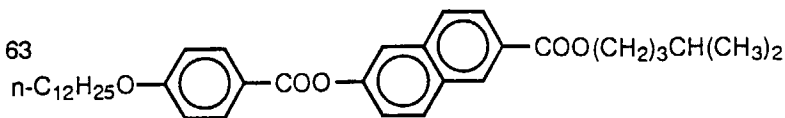
Exemplified compound 61



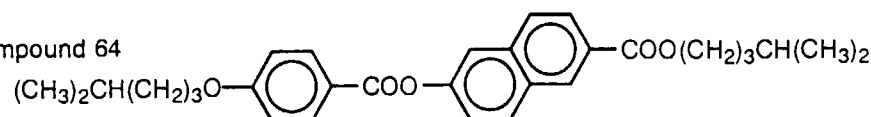
Exemplified compound 62



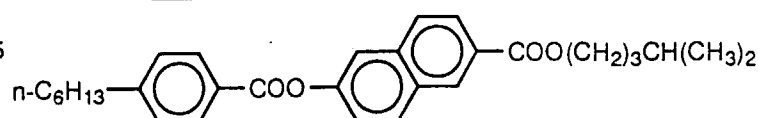
Exemplified compound 63



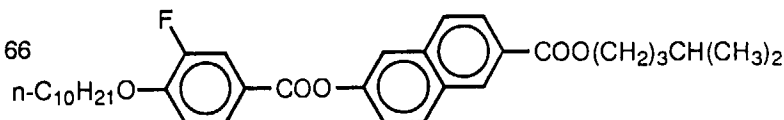
Exemplified compound 64



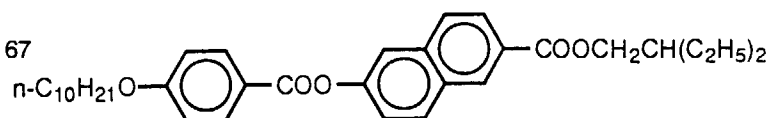
Exemplified compound 65



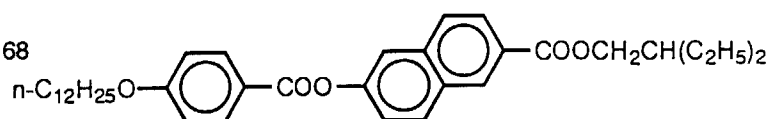
Exemplified compound 66



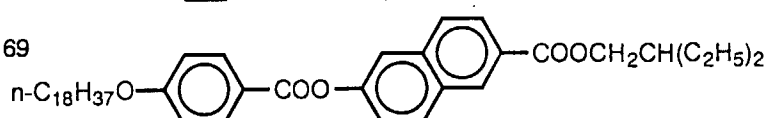
Exemplified compound 67



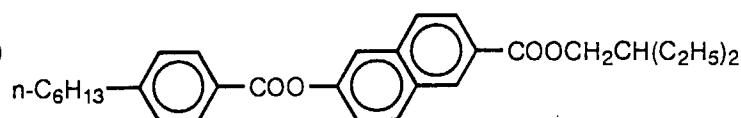
Exemplified compound 68



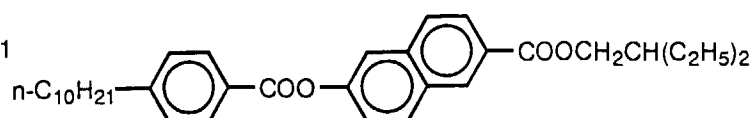
Exemplified compound 69



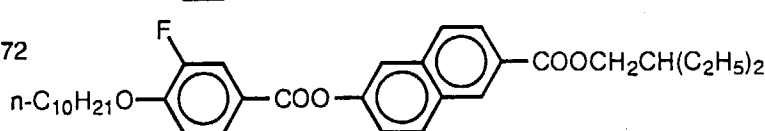
Exemplified compound 70



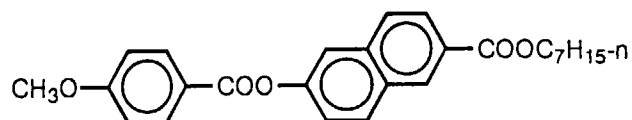
Exemplified compound 71



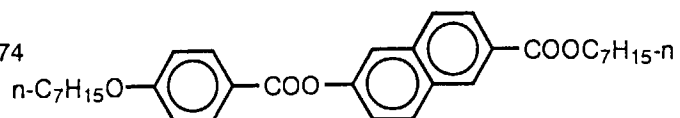
Exemplified compound 72



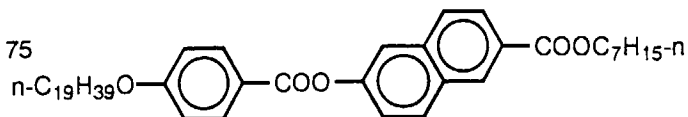
Exemplified compound 73



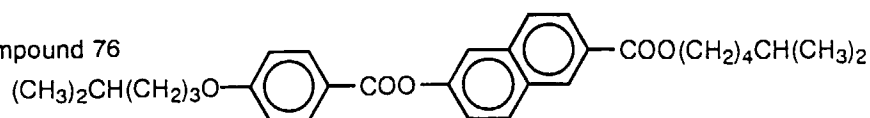
Exemplified compound 74



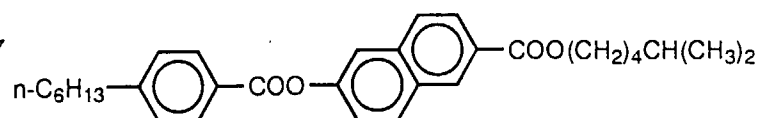
Exemplified compound 75



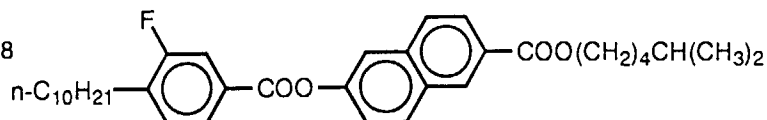
Exemplified compound 76



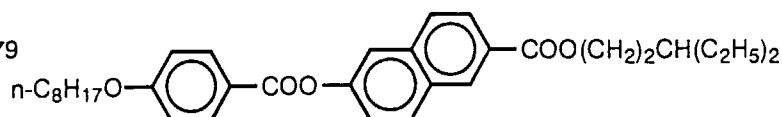
Exemplified compound 77



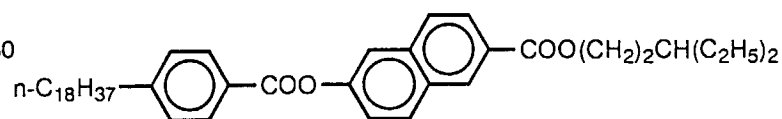
Exemplified compound 78



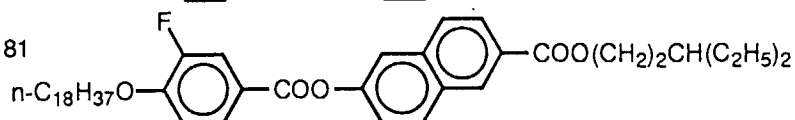
Exemplified compound 79



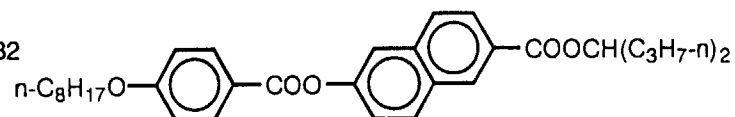
Exemplified compound 80



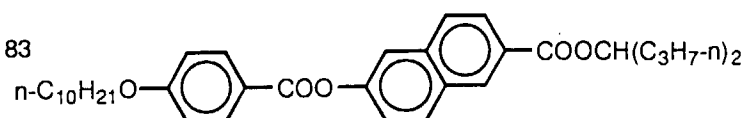
Exemplified compound 81



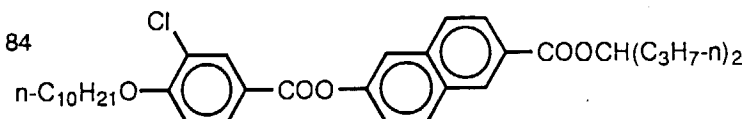
Exemplified compound 82



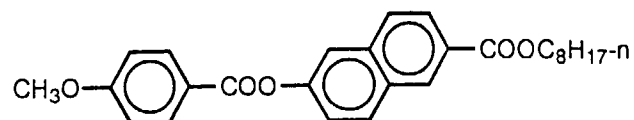
Exemplified compound 83



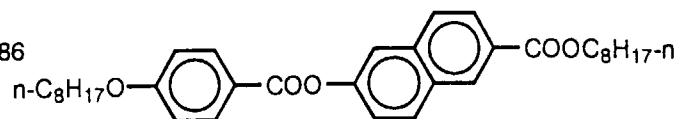
Exemplified compound 84



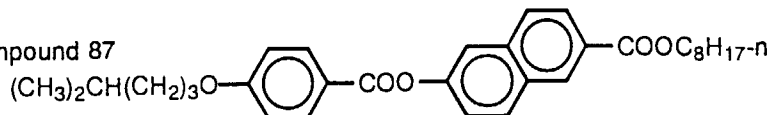
Exemplified compound 85



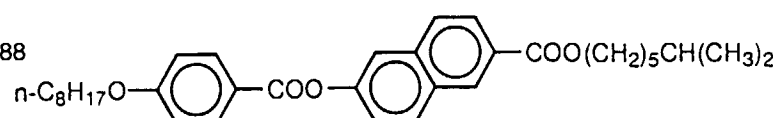
Exemplified compound 86



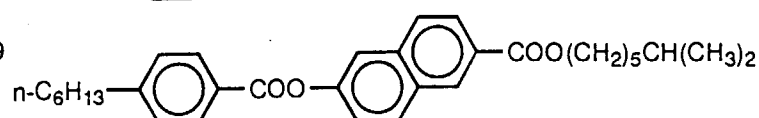
Exemplified compound 87



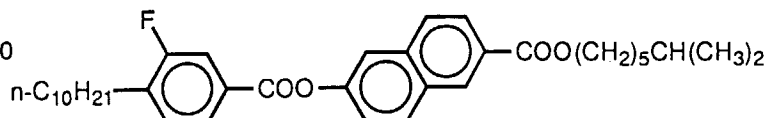
Exemplified compound 88



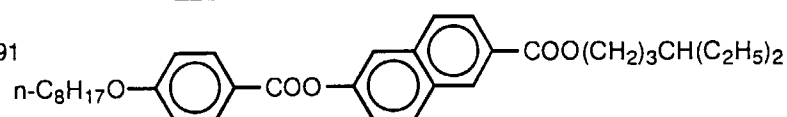
Exemplified compound 89



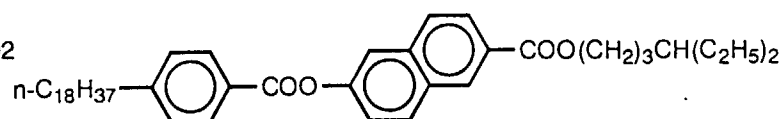
Exemplified compound 90



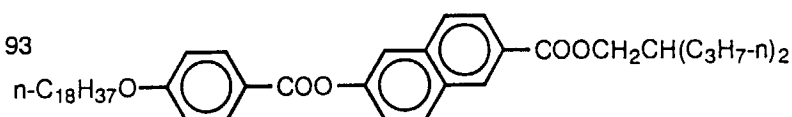
Exemplified compound 91



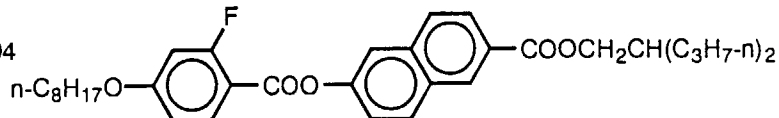
Exemplified compound 92



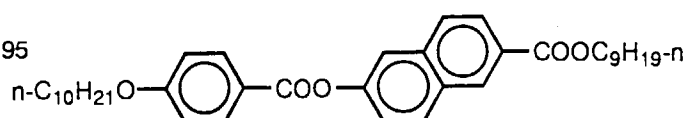
Exemplified compound 93



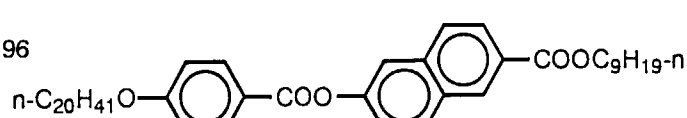
Exemplified compound 94

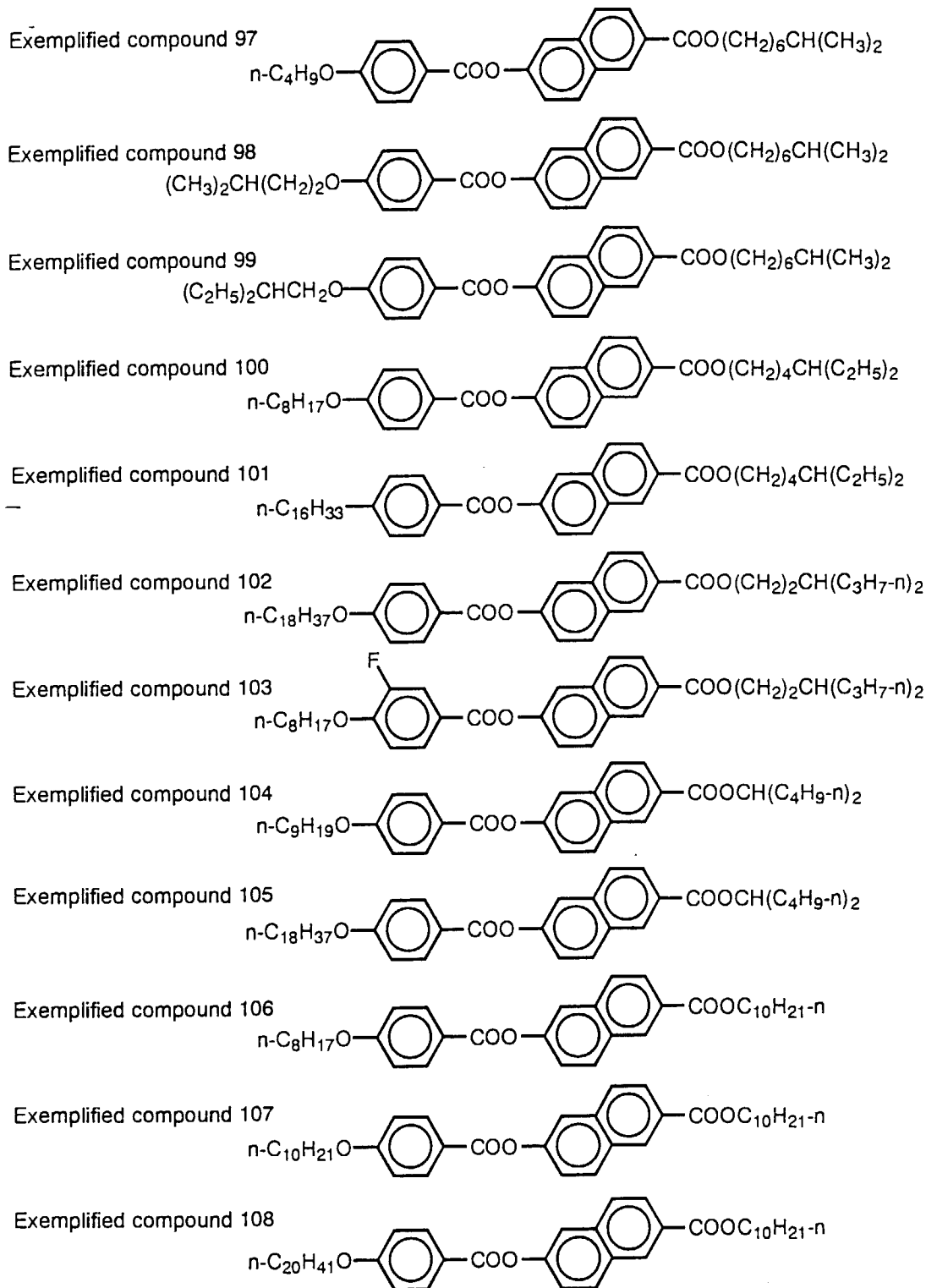


Exemplified compound 95

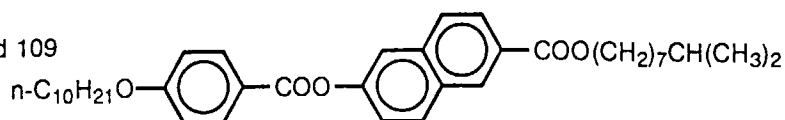


Exemplified compound 96

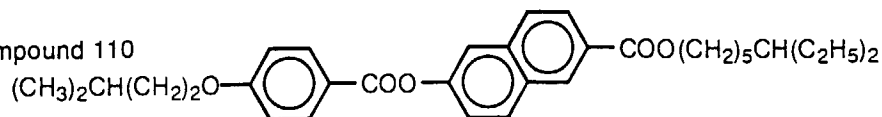




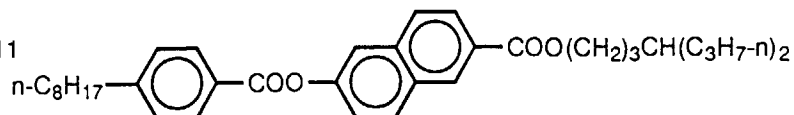
Exemplified compound 109



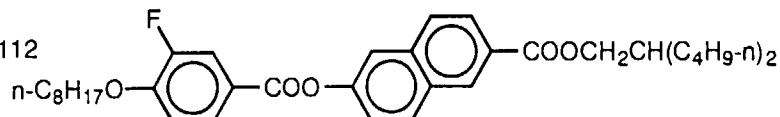
Exemplified compound 110



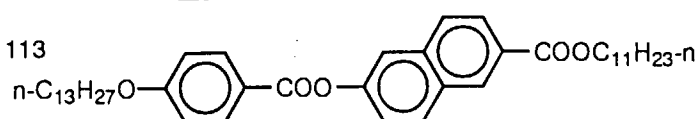
Exemplified compound 111



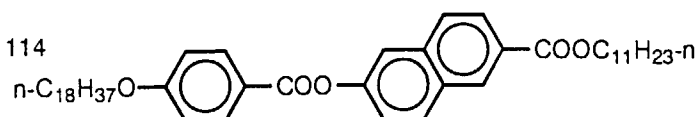
Exemplified compound 112



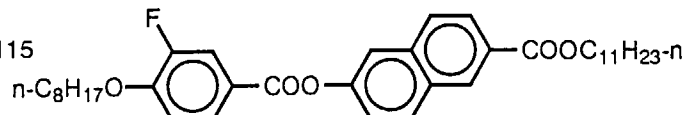
Exemplified compound 113



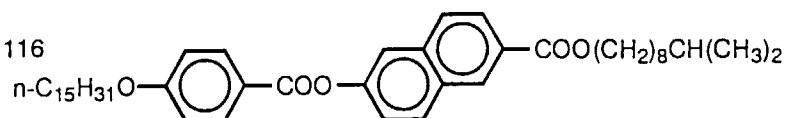
Exemplified compound 114



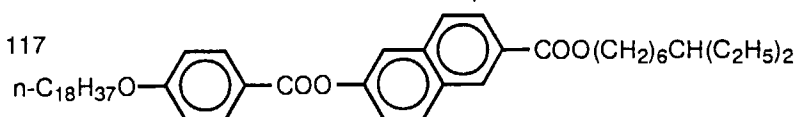
Exemplified compound 115



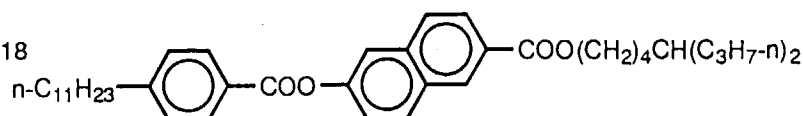
Exemplified compound 116



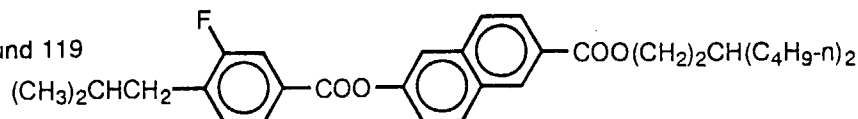
Exemplified compound 117



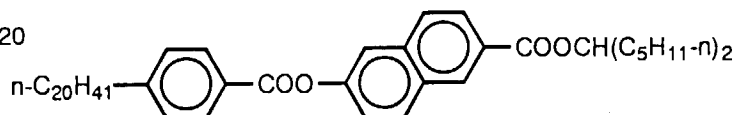
Exemplified compound 118



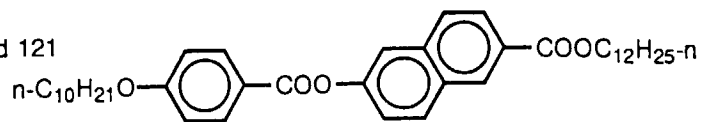
Exemplified compound 119



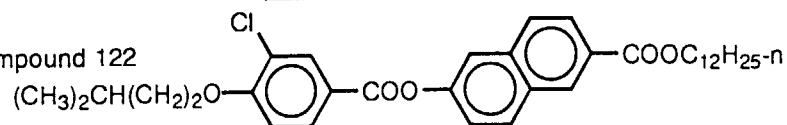
Exemplified compound 120



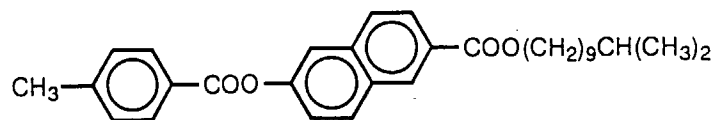
Exemplified compound 121



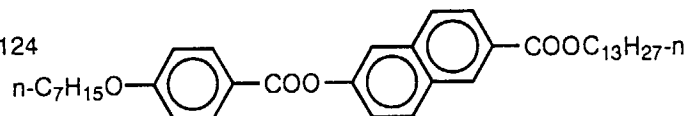
Exemplified compound 122



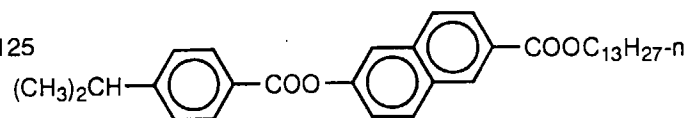
Exemplified compound 123



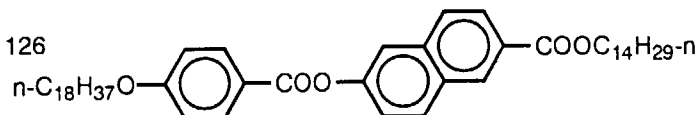
Exemplified compound 124



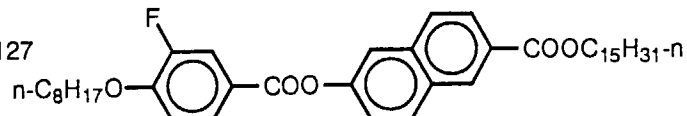
Exemplified compound 125



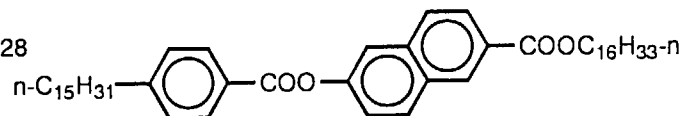
Exemplified compound 126



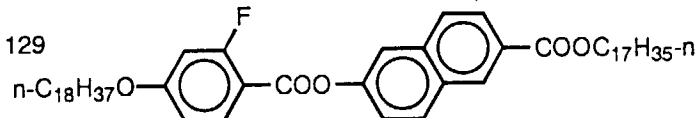
Exemplified compound 127



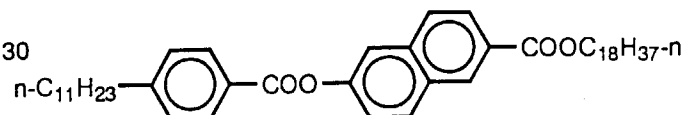
Exemplified compound 128



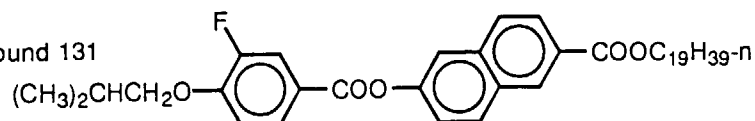
Exemplified compound 129



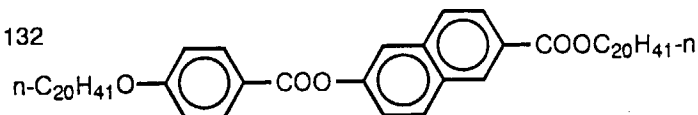
Exemplified compound 130



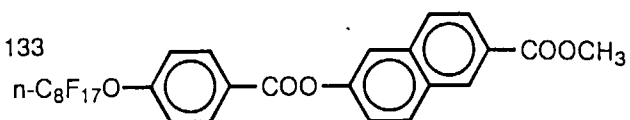
Exemplified compound 131



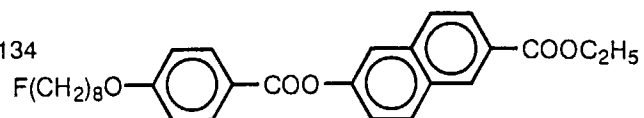
Exemplified compound 132



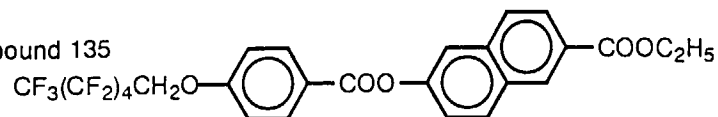
Exemplified compound 133



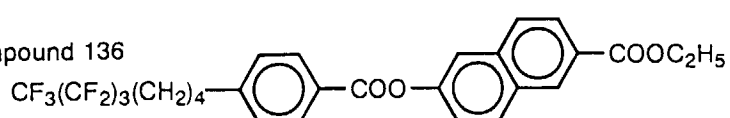
Exemplified compound 134



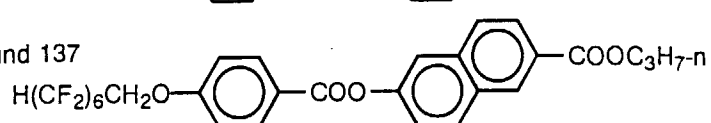
Exemplified compound 135



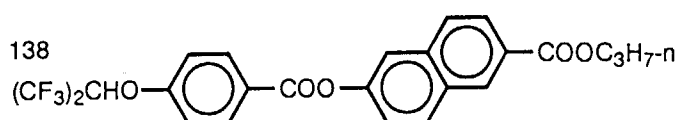
Exemplified compound 136



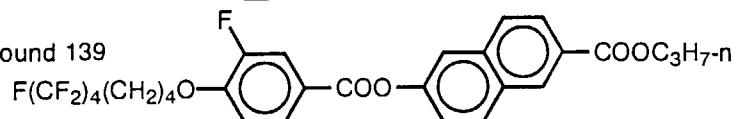
Exemplified compound 137



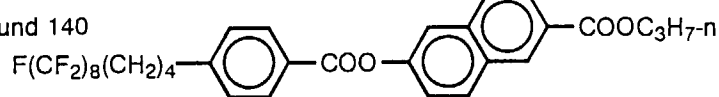
Exemplified compound 138



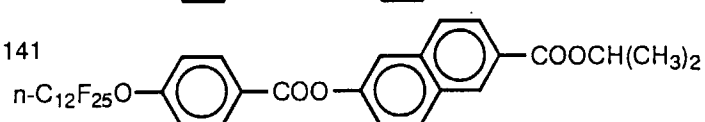
Exemplified compound 139



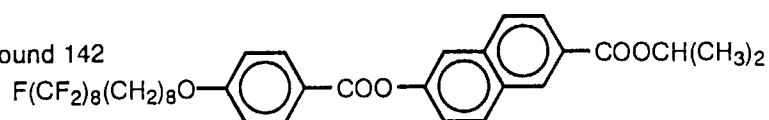
Exemplified compound 140



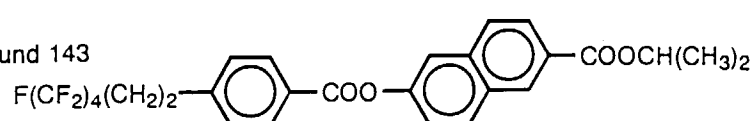
Exemplified compound 141



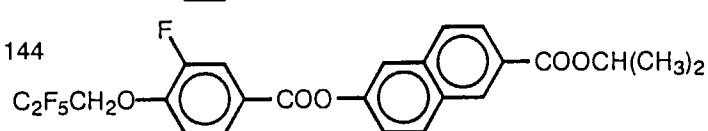
Exemplified compound 142



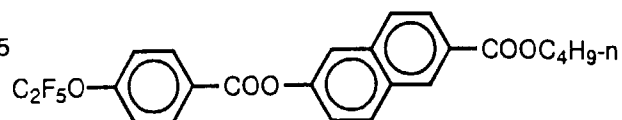
Exemplified compound 143



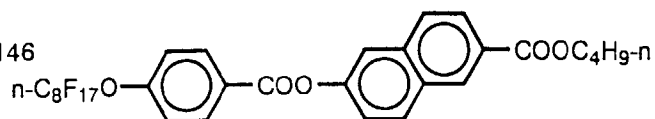
Exemplified compound 144



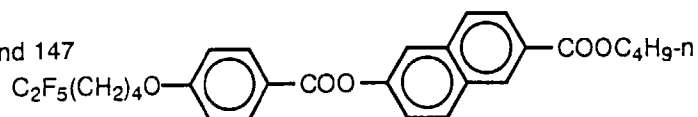
Exemplified compound 145



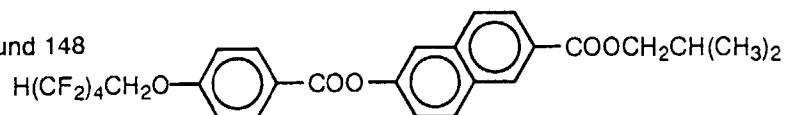
Exemplified compound 146



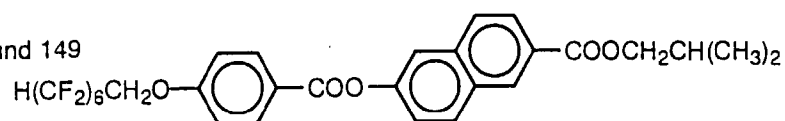
Exemplified compound 147



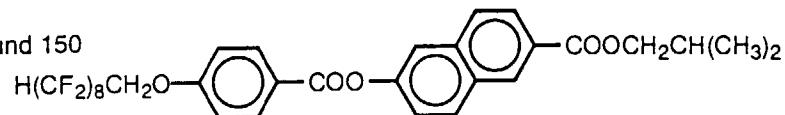
Exemplified compound 148



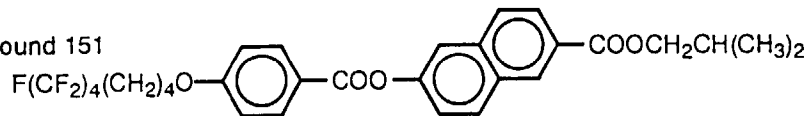
Exemplified compound 149



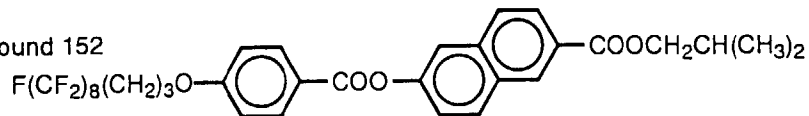
Exemplified compound 150



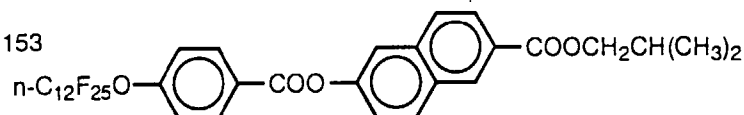
Exemplified compound 151



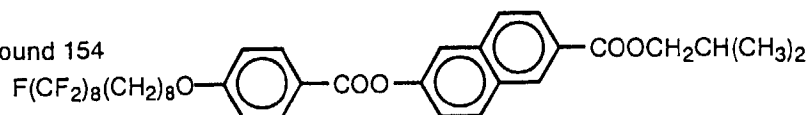
Exemplified compound 152



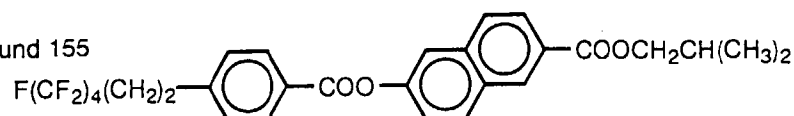
Exemplified compound 153



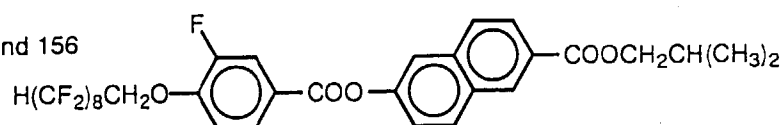
Exemplified compound 154



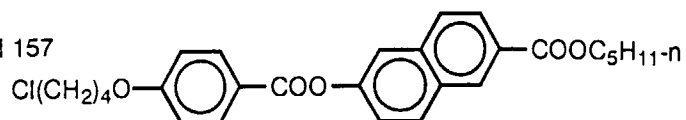
Exemplified compound 155



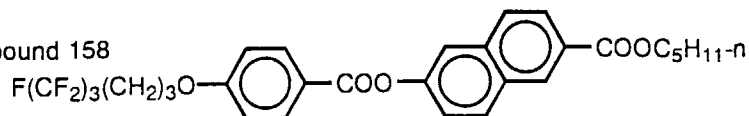
Exemplified compound 156



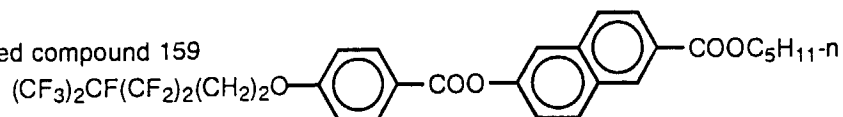
Exemplified compound 157



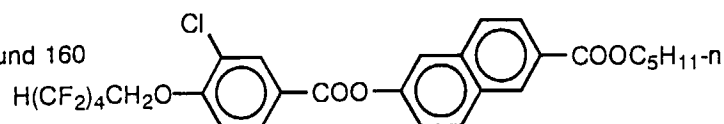
Exemplified compound 158



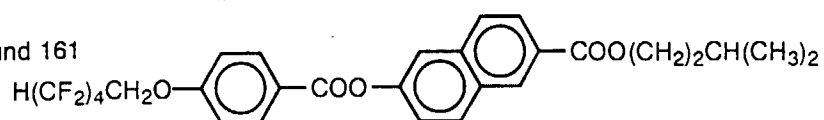
Exemplified compound 159



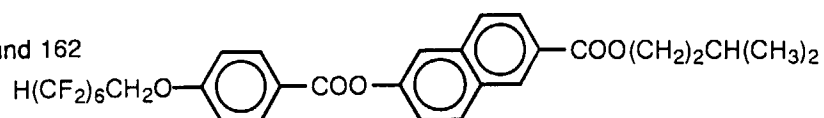
Exemplified compound 160



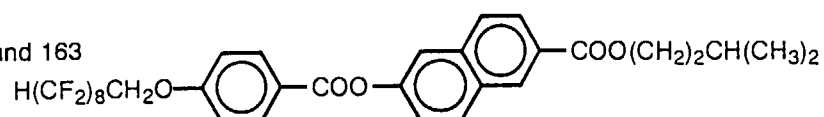
Exemplified compound 161



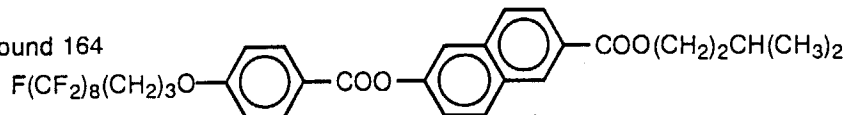
Exemplified compound 162



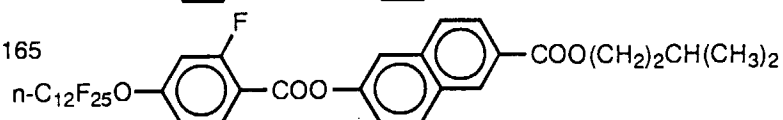
Exemplified compound 163



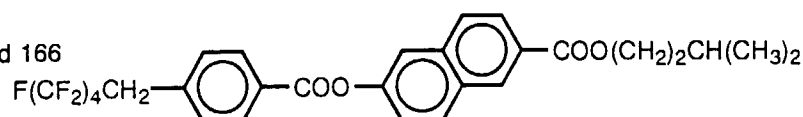
Exemplified compound 164



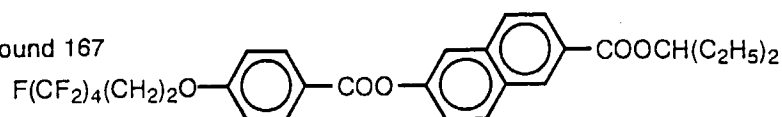
Exemplified compound 165



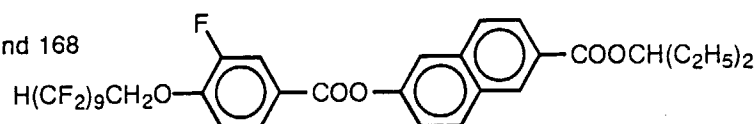
Exemplified compound 166



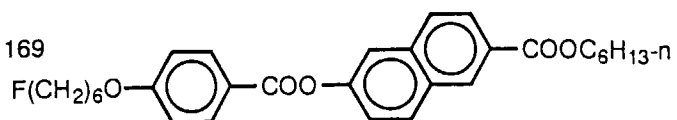
Exemplified compound 167



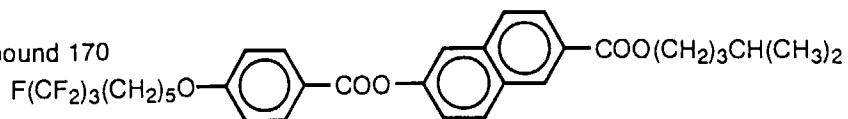
Exemplified compound 168



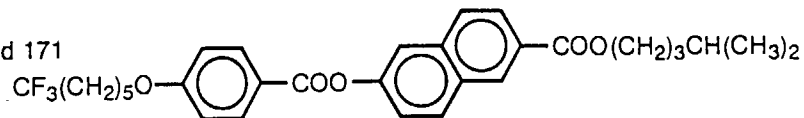
Exemplified compound 169



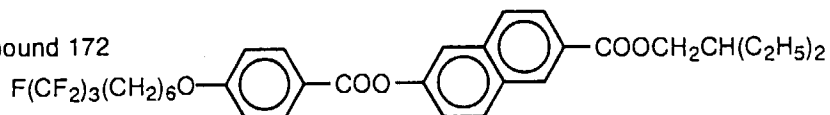
Exemplified compound 170



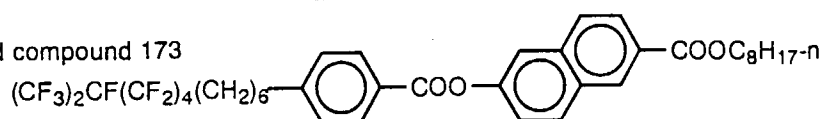
Exemplified compound 171



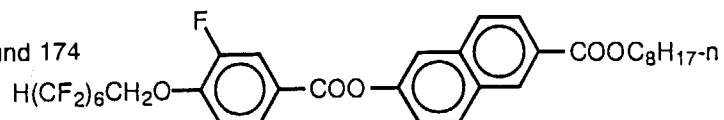
Exemplified compound 172



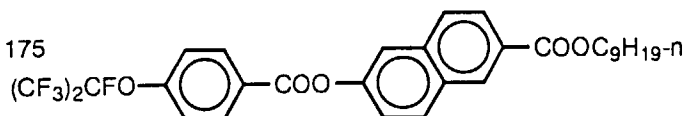
Exemplified compound 173



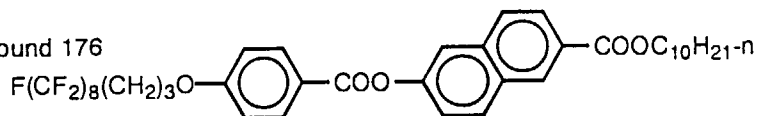
Exemplified compound 174



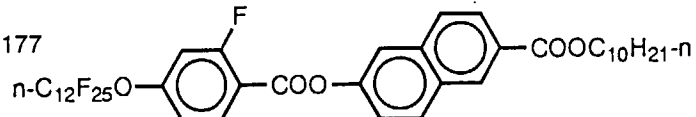
Exemplified compound 175



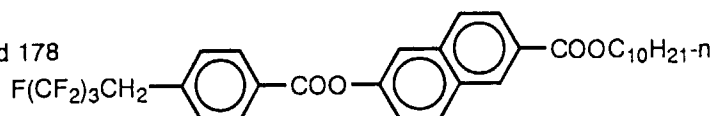
Exemplified compound 176



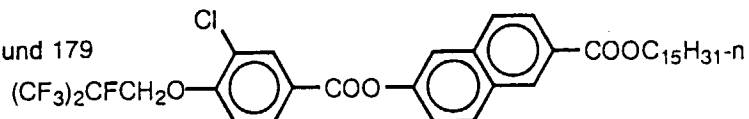
Exemplified compound 177



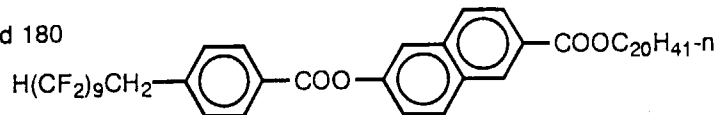
Exemplified compound 178

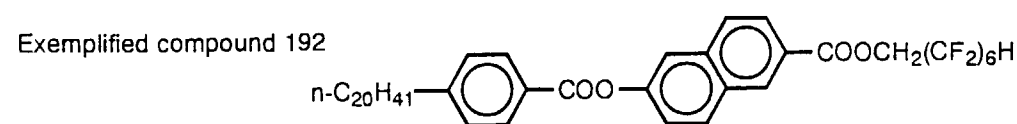
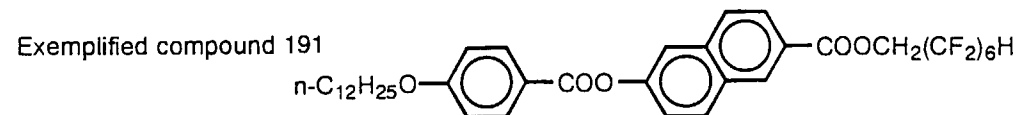
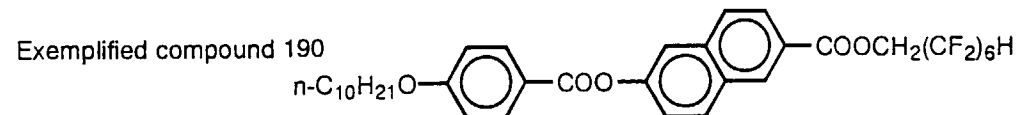
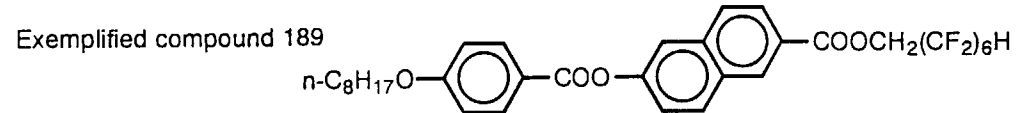
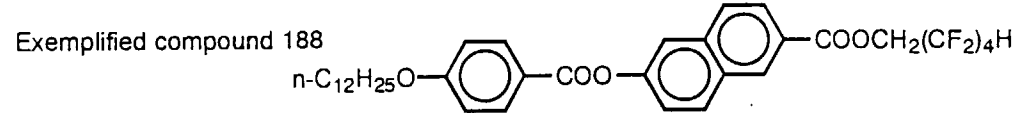
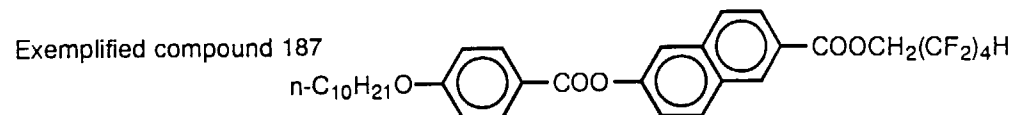
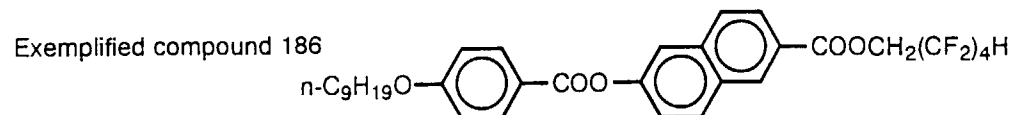
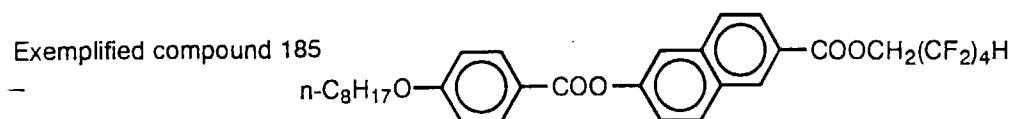
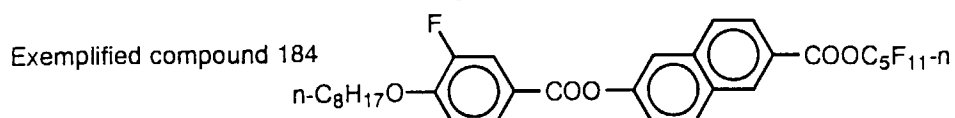
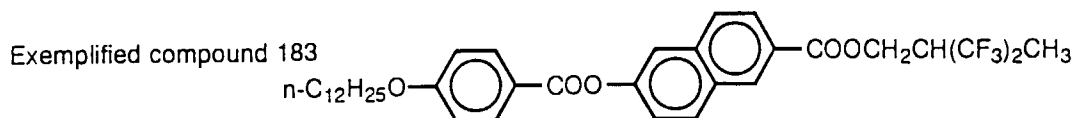
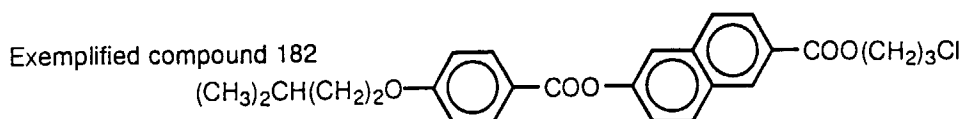
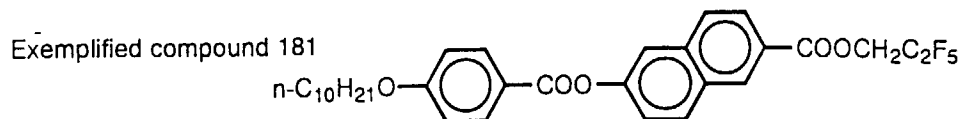


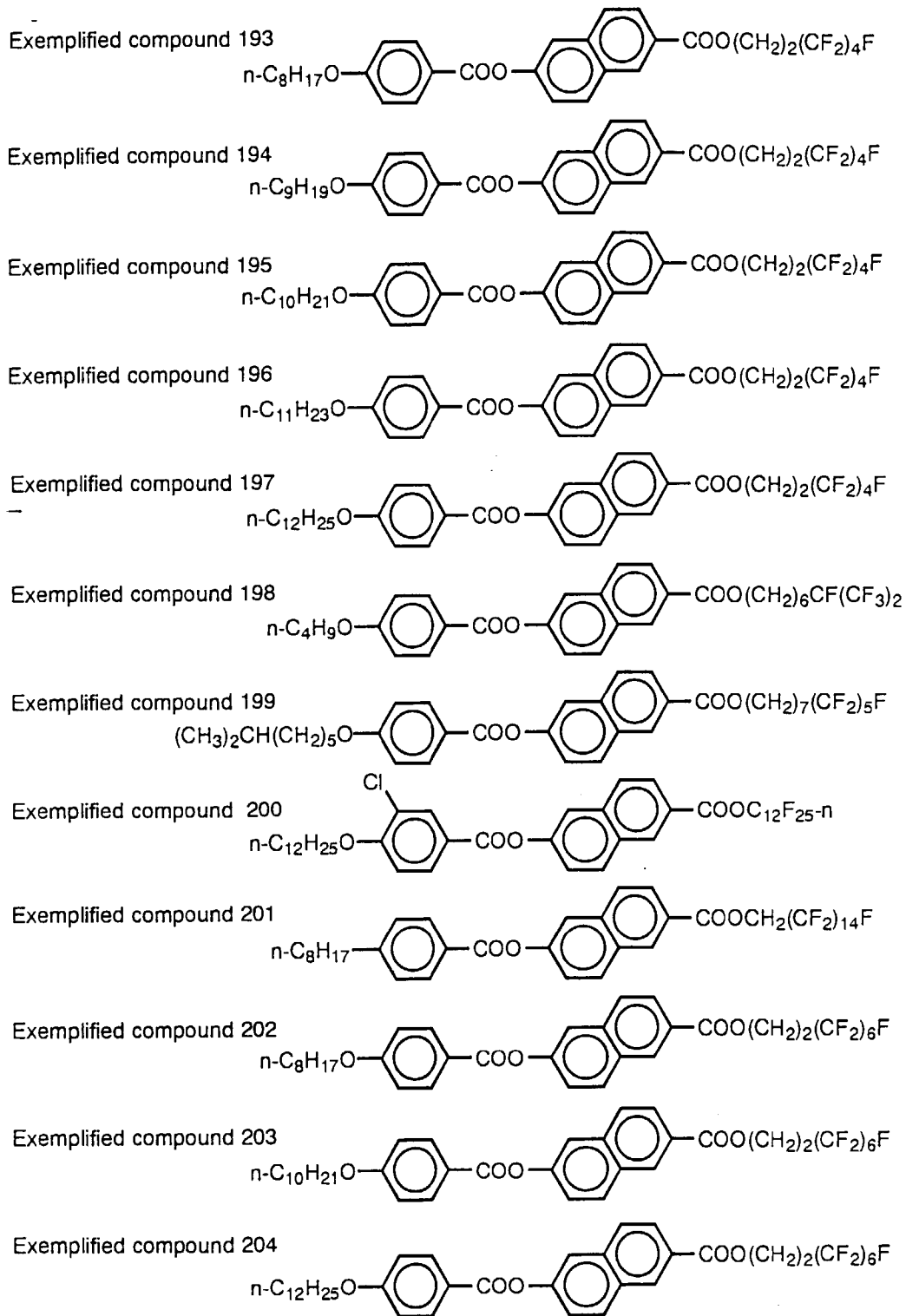
Exemplified compound 179



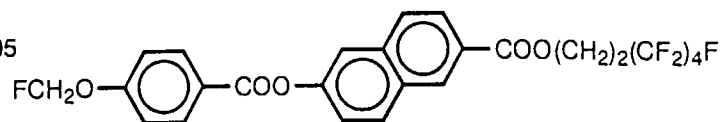
Exemplified compound 180



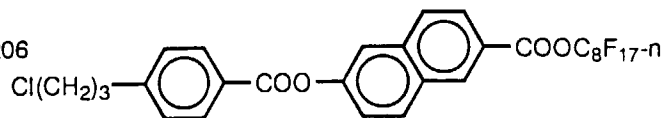




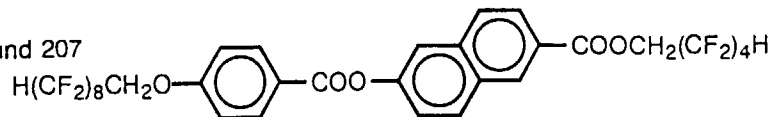
Exemplified compound 205



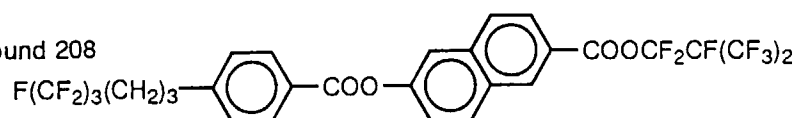
Exemplified compound 206



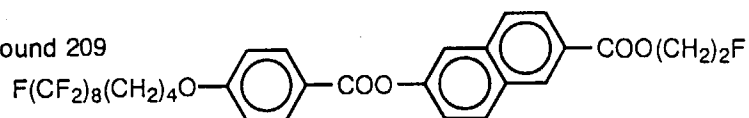
Exemplified compound 207



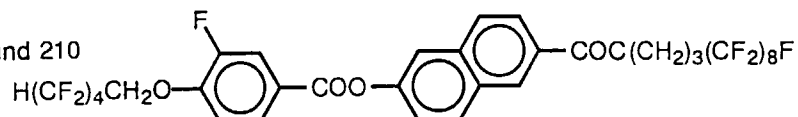
Exemplified compound 208



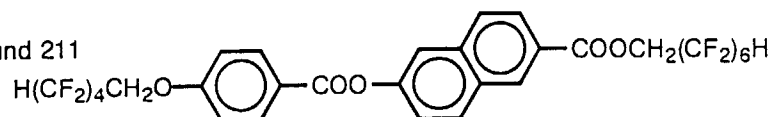
Exemplified compound 209



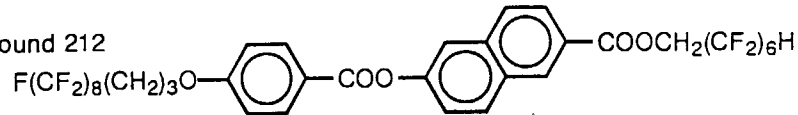
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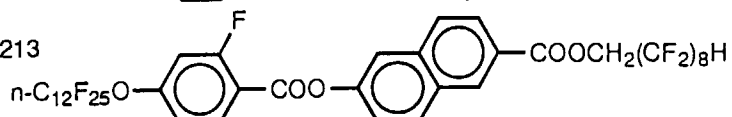
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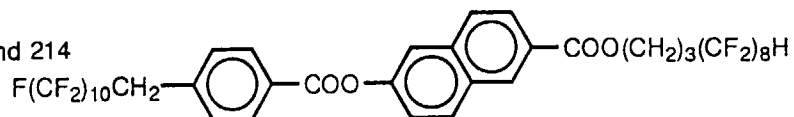
Exemplified compound 212



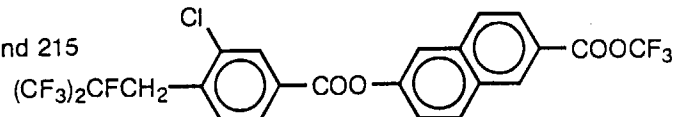
Exemplified compound 213



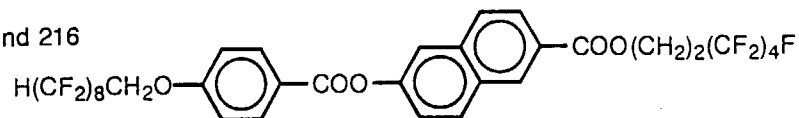
Exemplified compound 214



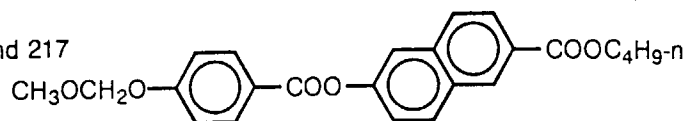
Exemplified compound 215



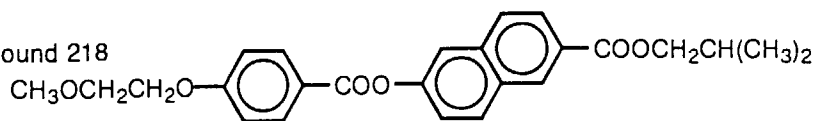
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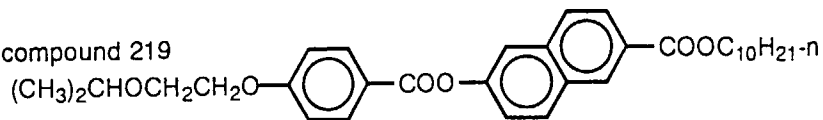
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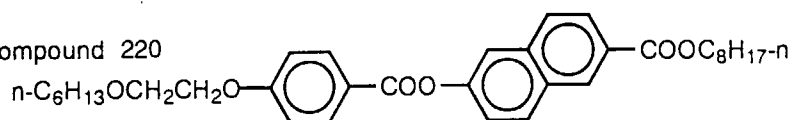
Exemplified compound 218



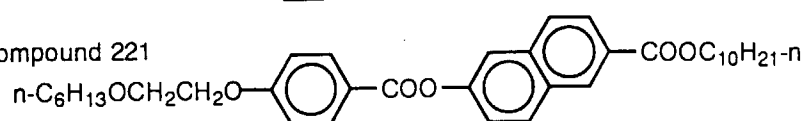
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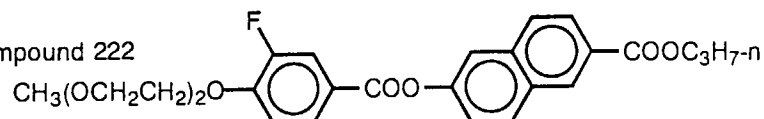
Exemplified compound 220



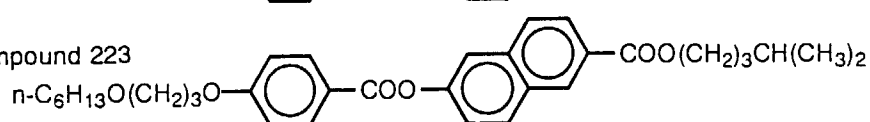
Exemplified compound 221



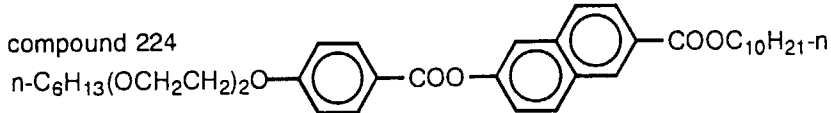
Exemplified compound 222



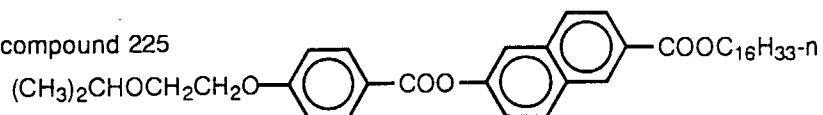
Exemplified compound 223



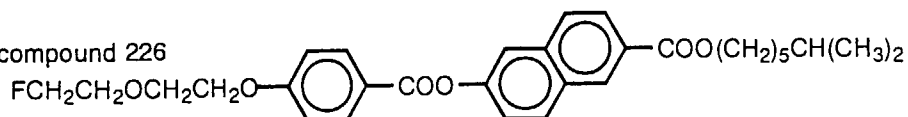
Exemplified compound 224



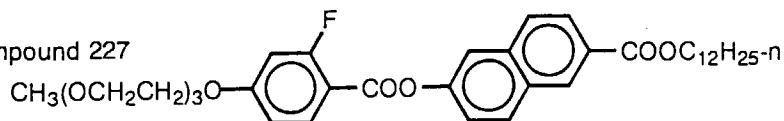
Exemplified compound 225



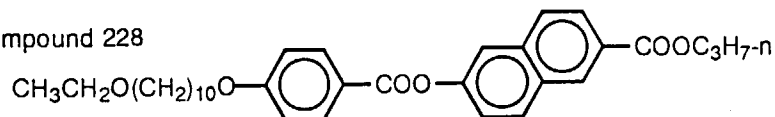
Exemplified compound 226

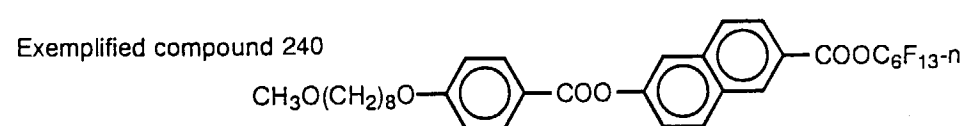
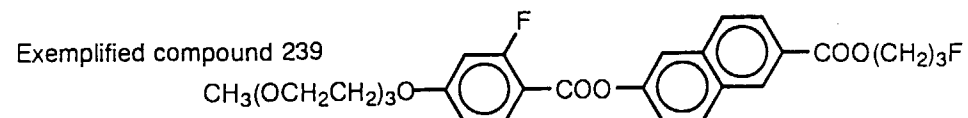
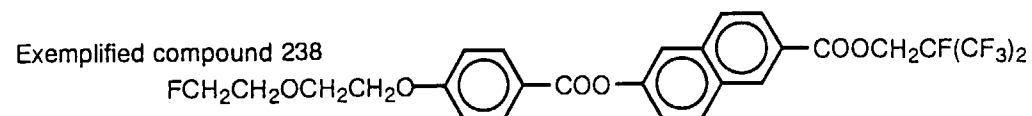
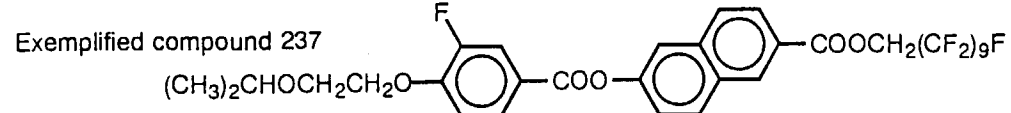
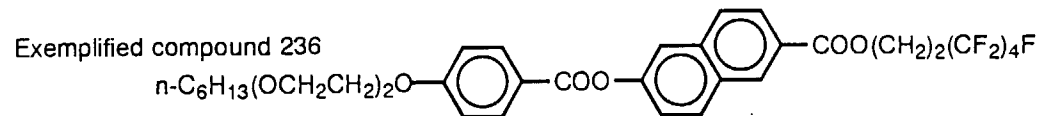
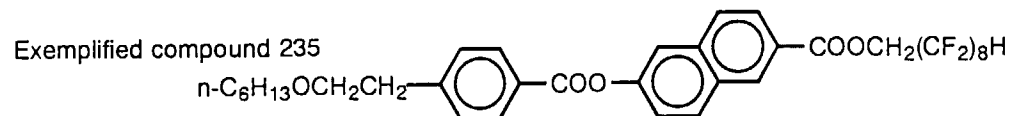
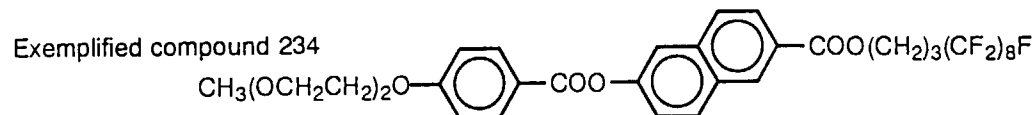
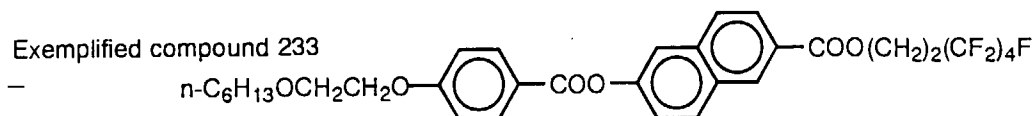
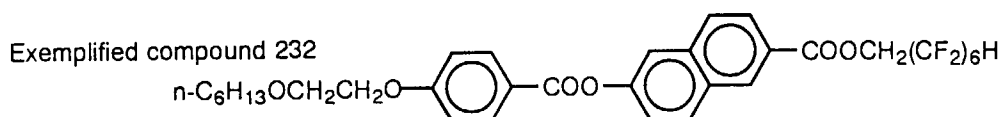
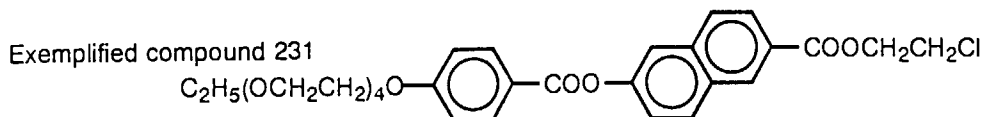
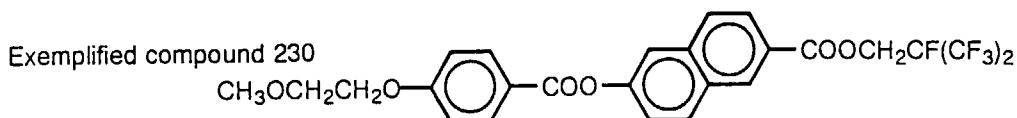
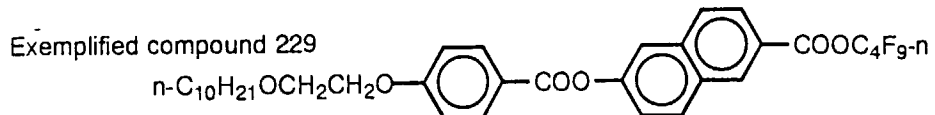


Exemplified compound 227

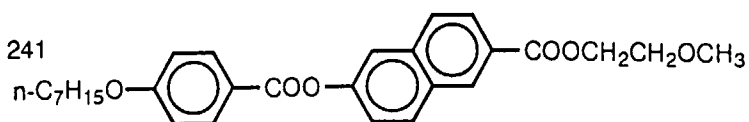


Exemplified compound 228

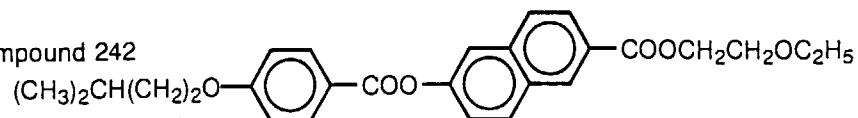




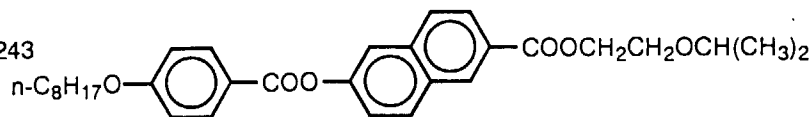
Exemplified compound 241



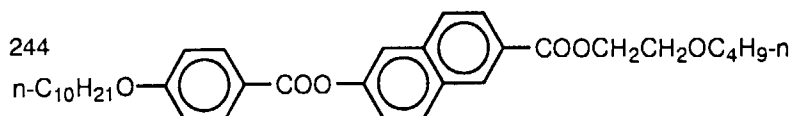
Exemplified compound 242



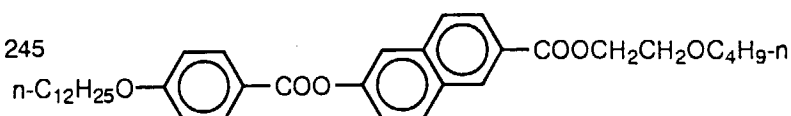
Exemplified compound 243



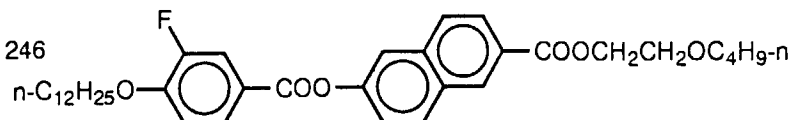
Exemplified compound 244



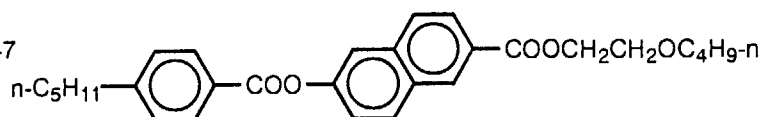
Exemplified compound 245



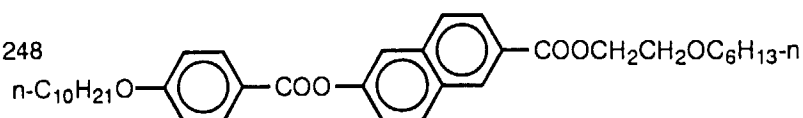
Exemplified compound 246



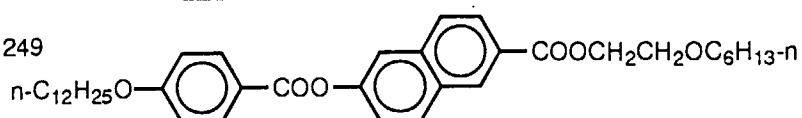
Exemplified compound 247



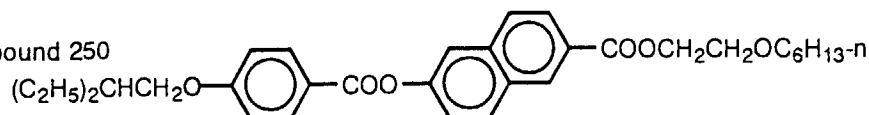
Exemplified compound 248



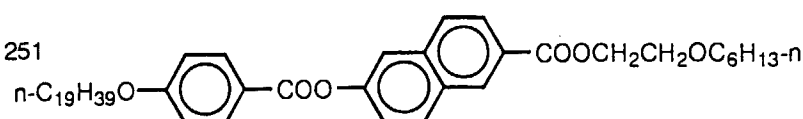
Exemplified compound 249



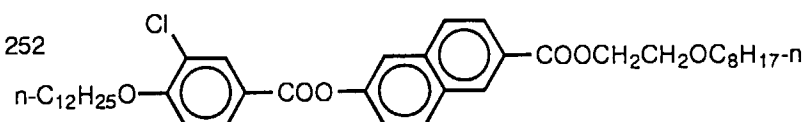
Exemplified compound 250



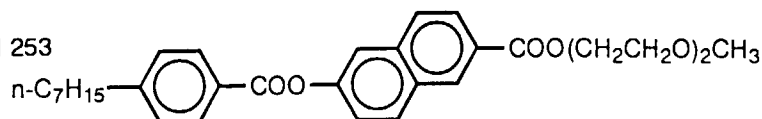
Exemplified compound 251



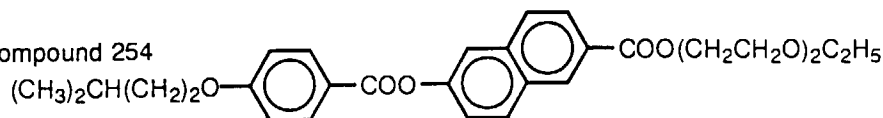
Exemplified compound 252



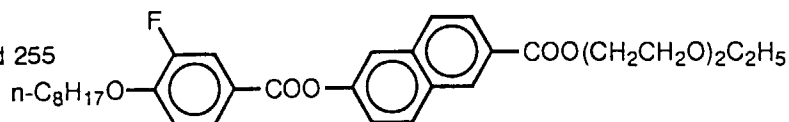
Exemplified compound 253



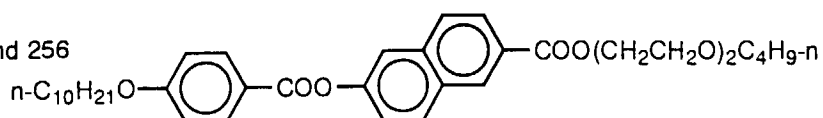
Exemplified compound 254



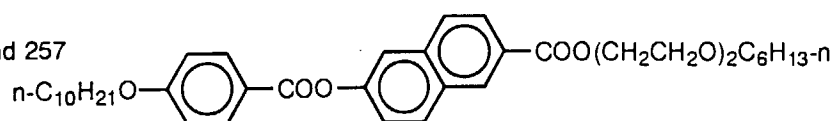
Exemplified compound 255



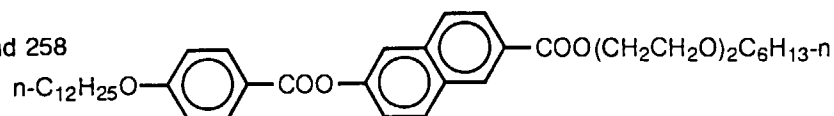
Exemplified compound 256



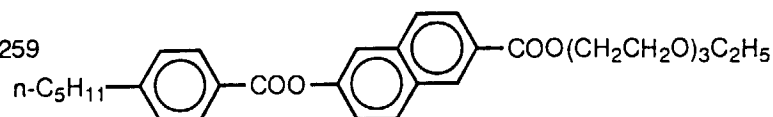
Exemplified compound 257



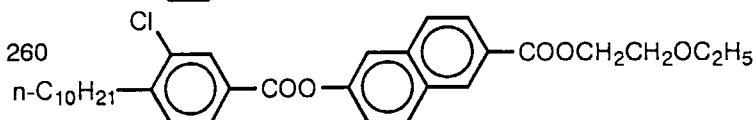
Exemplified compound 258



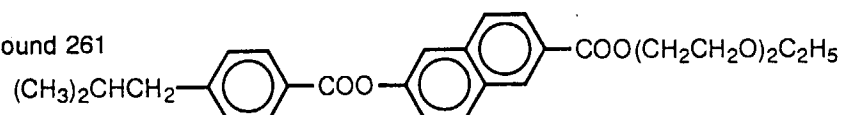
Exemplified compound 259



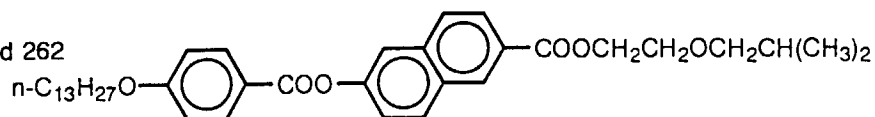
Exemplified compound 260



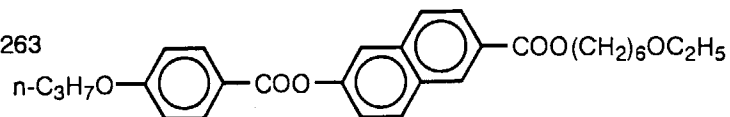
Exemplified compound 261



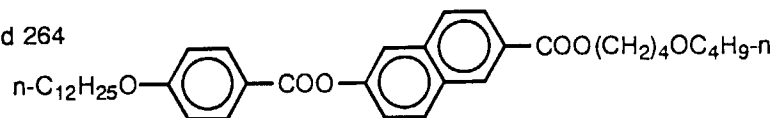
Exemplified compound 262



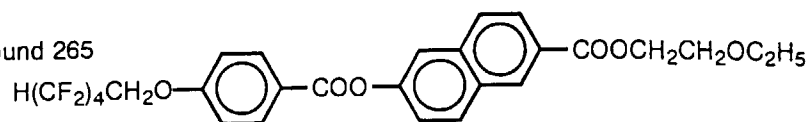
Exemplified compound 263



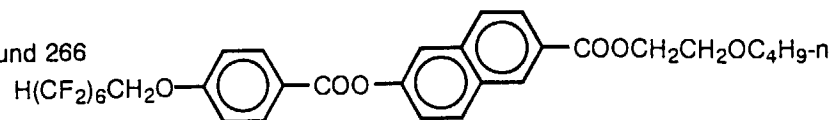
Exemplified compound 264



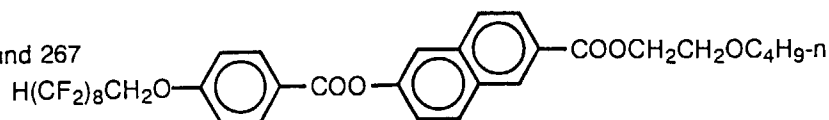
Exemplified compound 265



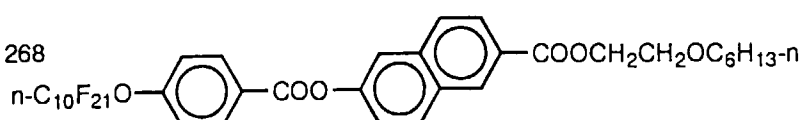
Exemplified compound 266



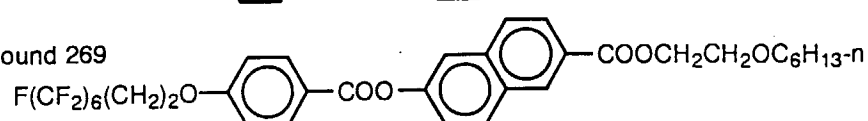
Exemplified compound 267



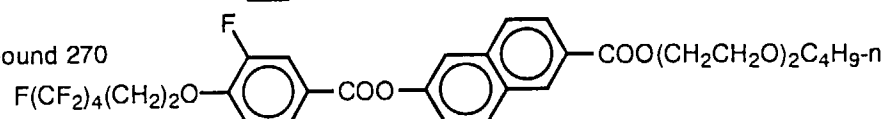
Exemplified compound 268



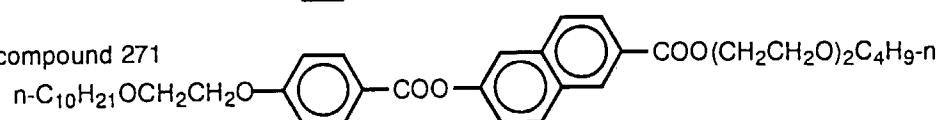
Exemplified compound 269



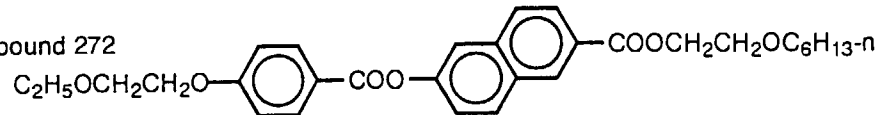
Exemplified compound 270



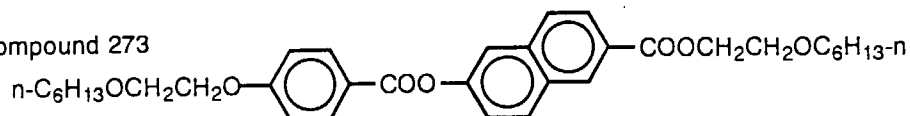
Exemplified compound 271



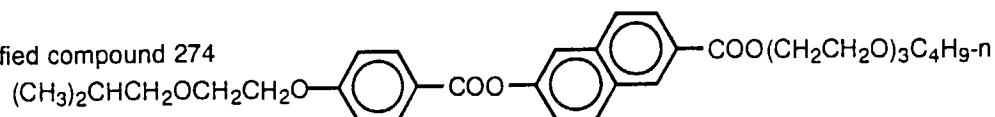
Exemplified compound 272



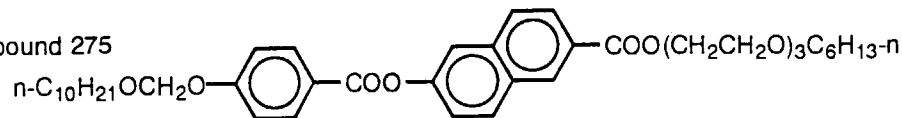
Exemplified compound 273



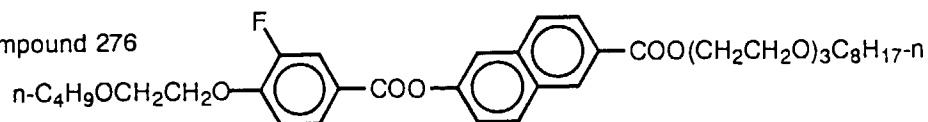
Exemplified compound 274



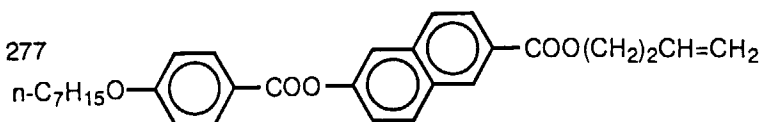
Exemplified compound 275



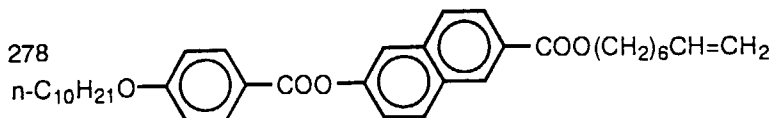
Exemplified compound 276



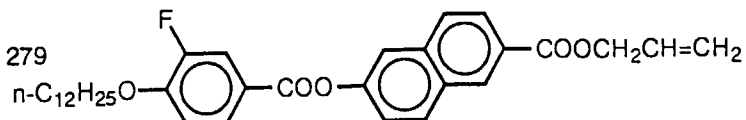
Exemplified compound 277



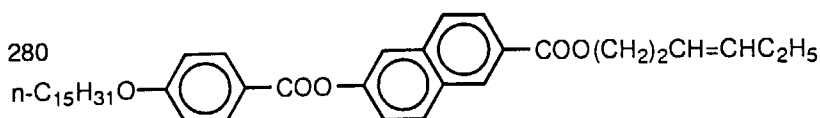
Exemplified compound 278



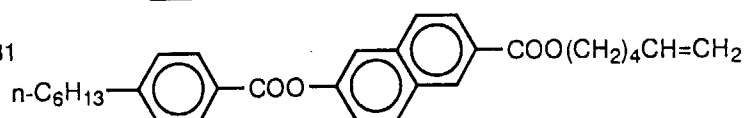
Exemplified compound 279



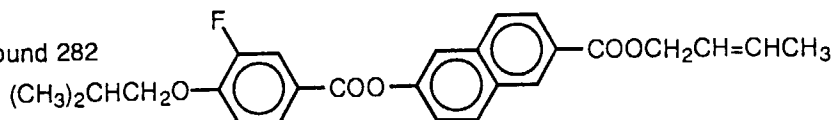
Exemplified compound 280



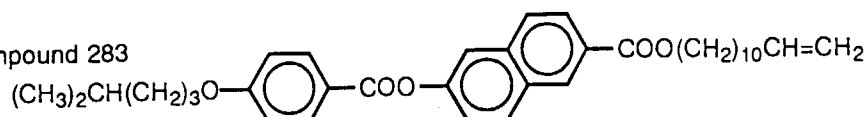
Exemplified compound 281



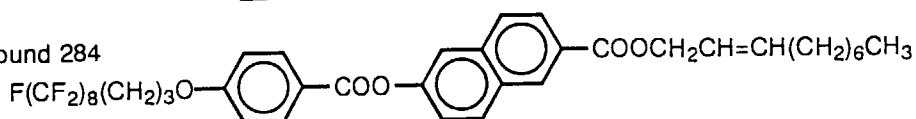
Exemplified compound 282



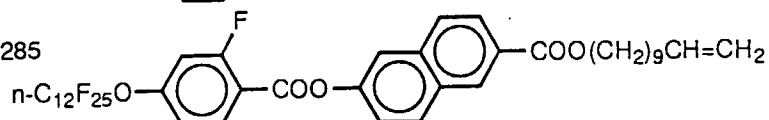
Exemplified compound 283



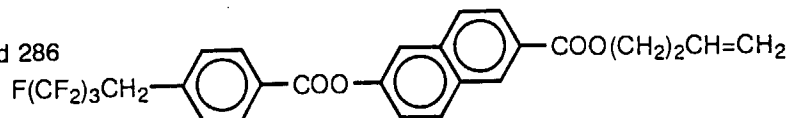
Exemplified compound 284



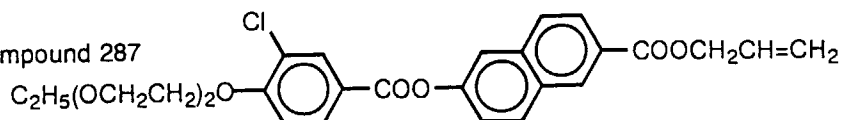
Exemplified compound 285



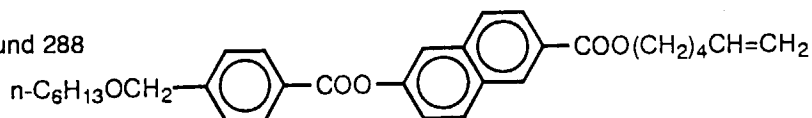
Exemplified compound 286



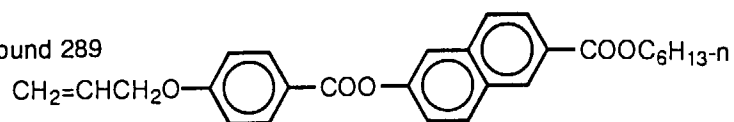
Exemplified compound 287



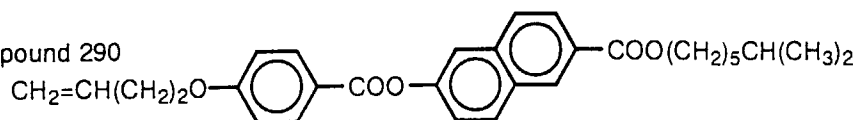
Exemplified compound 288



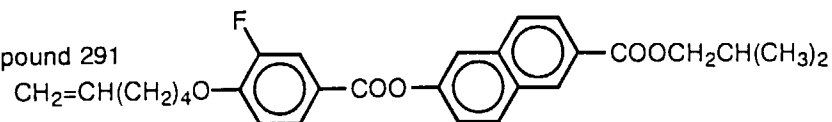
Exemplified compound 289



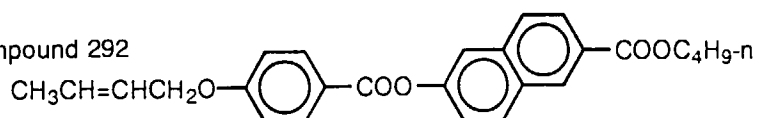
Exemplified compound 290



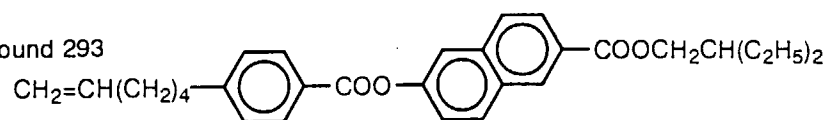
Exemplified compound 291



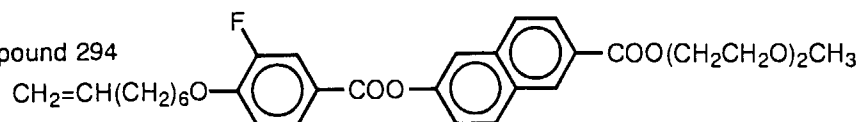
Exemplified compound 292



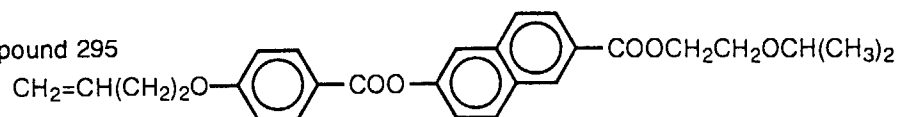
Exemplified compound 293



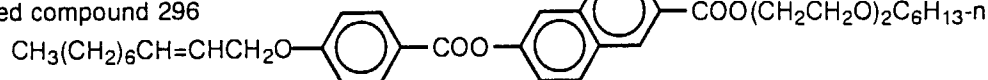
Exemplified compound 294



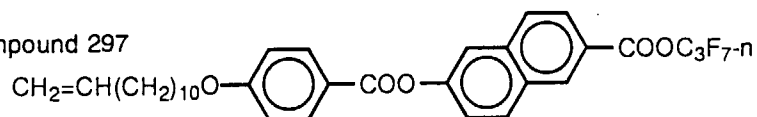
Exemplified compound 295



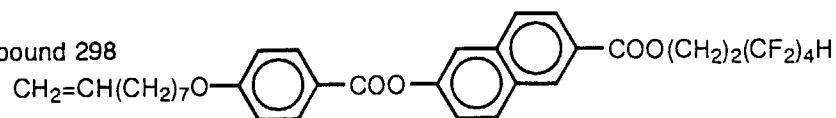
Exemplified compound 296



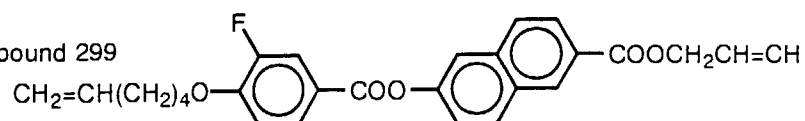
Exemplified compound 297



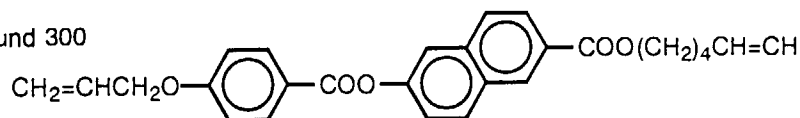
Exemplified compound 298



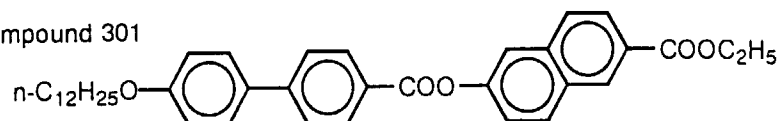
Exemplified compound 299



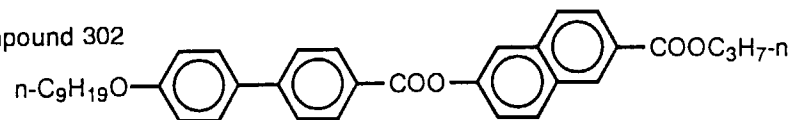
Exemplified compound 300



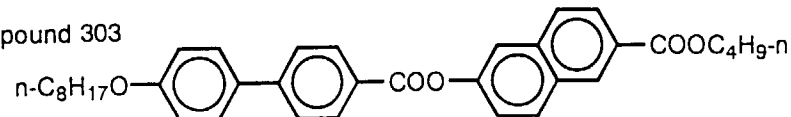
Exemplified compound 301



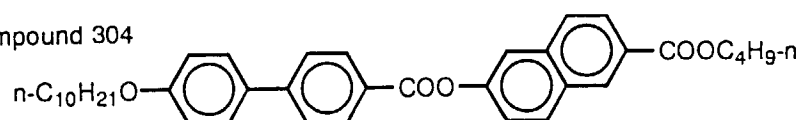
Exemplified compound 302



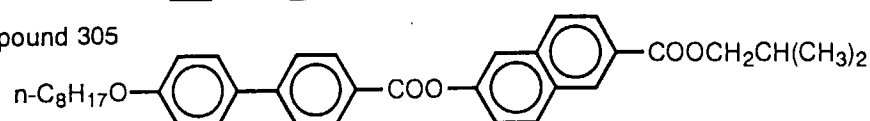
Exemplified compound 303



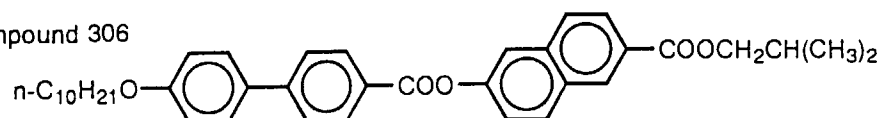
Exemplified compound 304



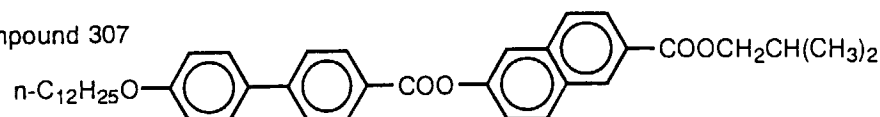
Exemplified compound 305



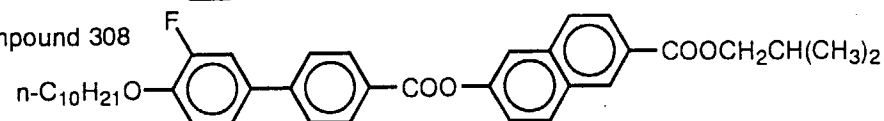
Exemplified compound 306



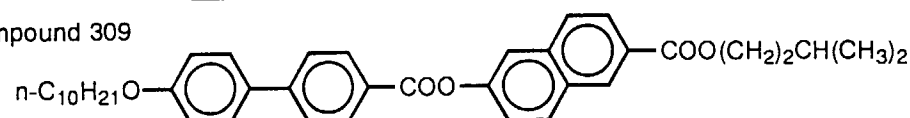
Exemplified compound 307



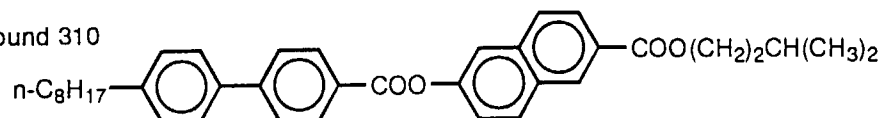
Exemplified compound 308



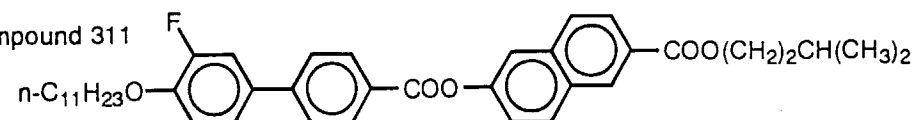
Exemplified compound 309



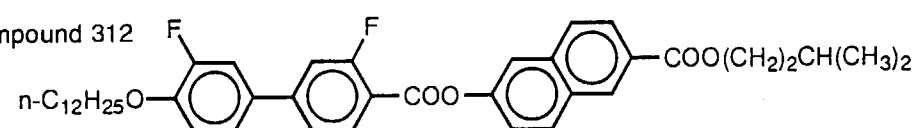
Exemplified compound 310



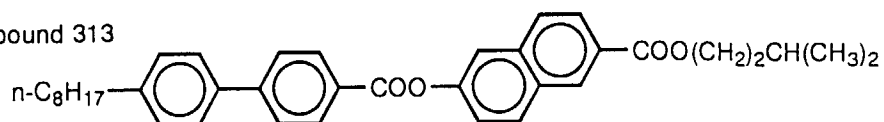
Exemplified compound 311



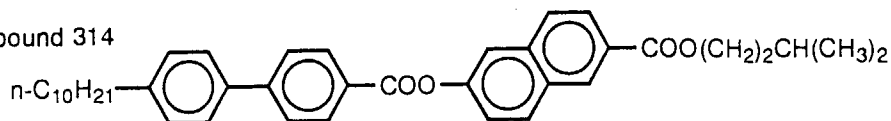
Exemplified compound 312



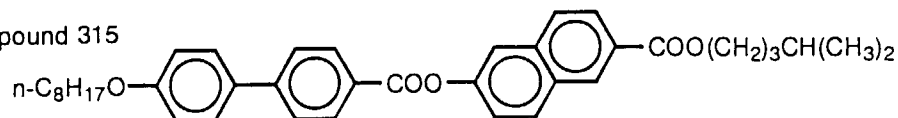
Exemplified compound 313



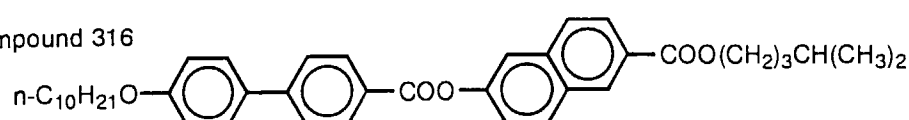
Exemplified compound 314



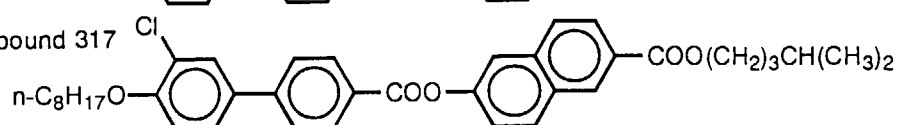
Exemplified compound 315



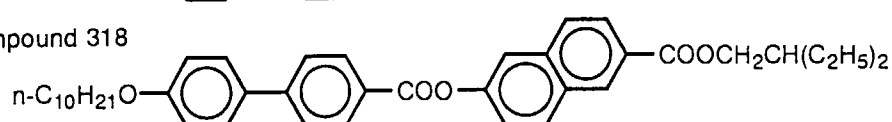
Exemplified compound 316



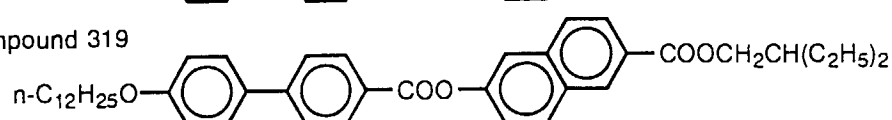
Exemplified compound 317



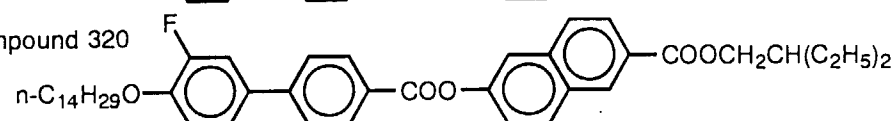
Exemplified compound 318



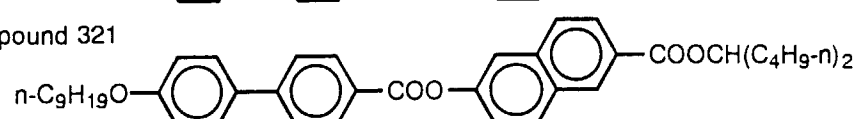
Exemplified compound 319



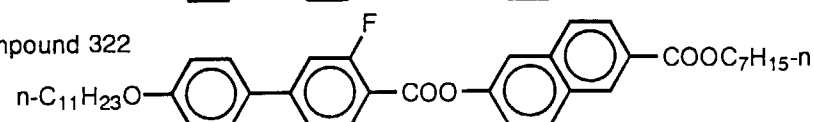
Exemplified compound 320



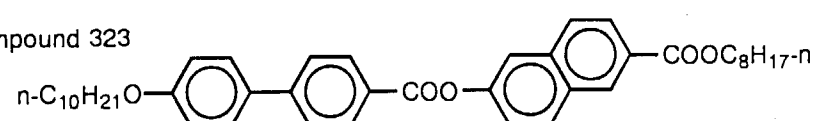
Exemplified compound 321



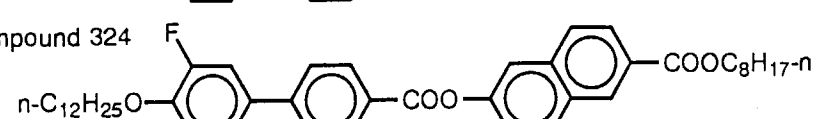
Exemplified compound 322



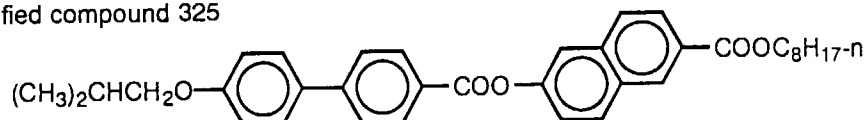
Exemplified compound 323



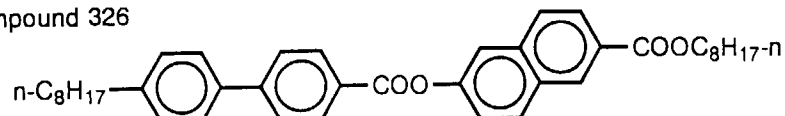
Exemplified compound 324



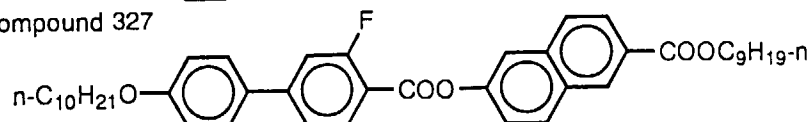
Exemplified compound 325



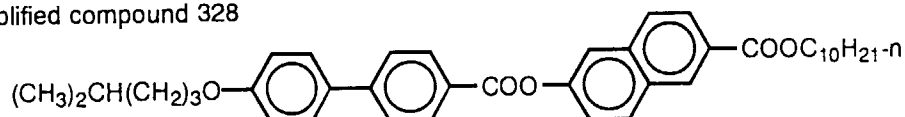
Exemplified compound 326



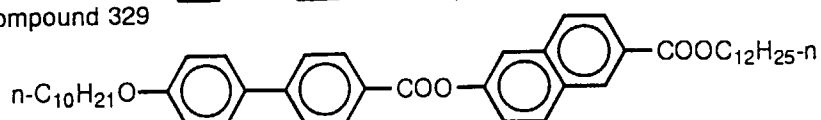
Exemplified compound 327



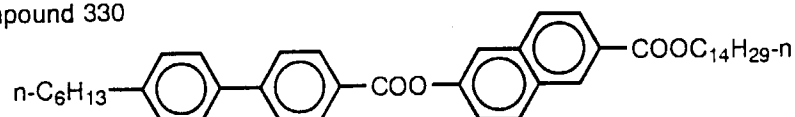
Exemplified compound 328



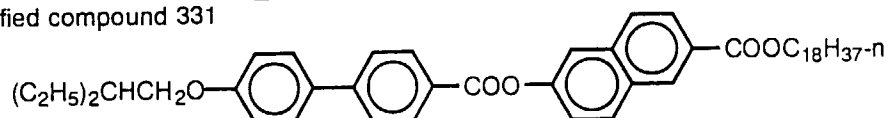
Exemplified compound 329



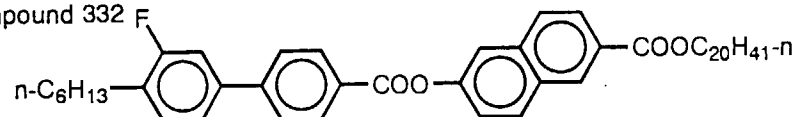
Exemplified compound 330



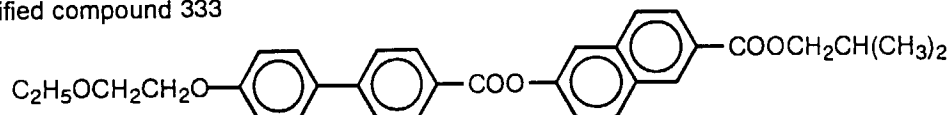
Exemplified compound 331



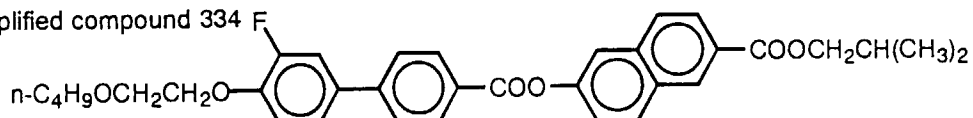
Exemplified compound 332



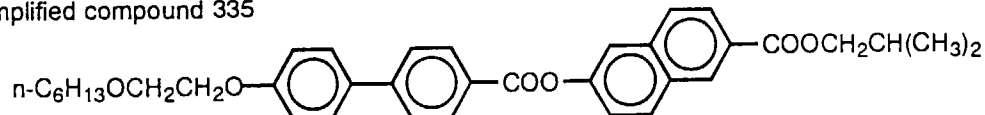
Exemplified compound 333



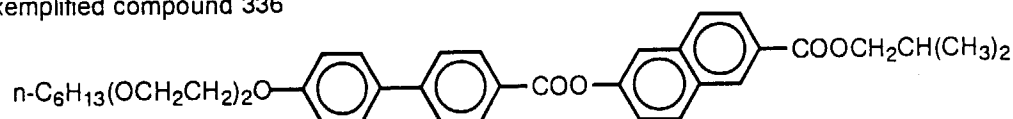
Exemplified compound 334

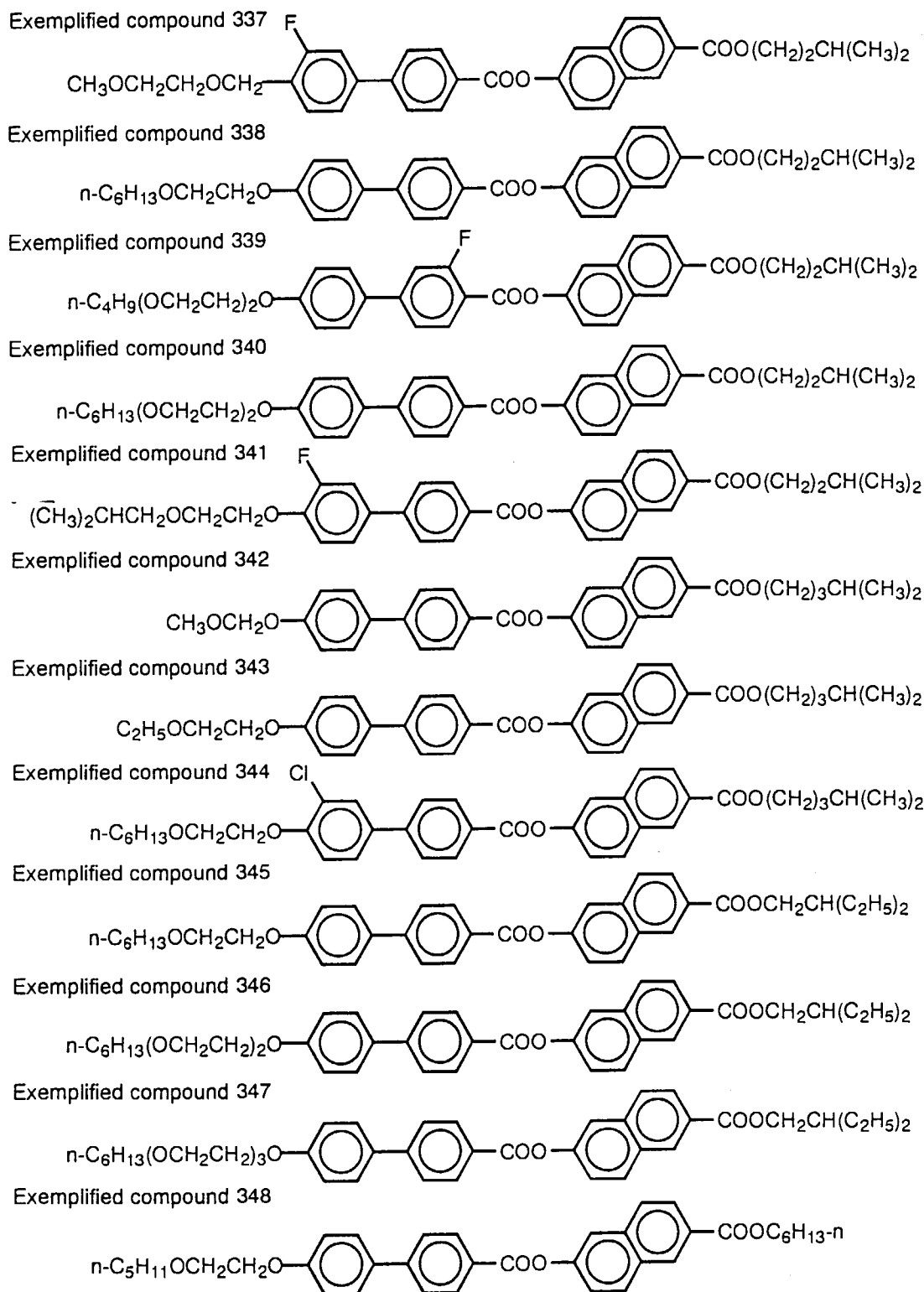


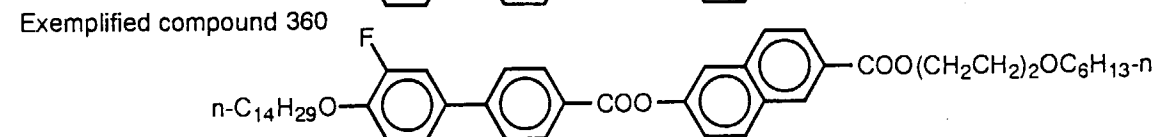
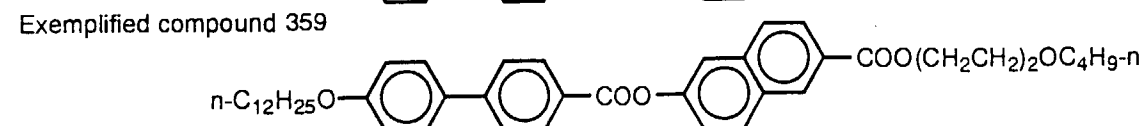
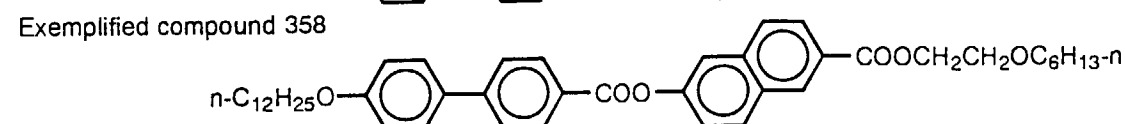
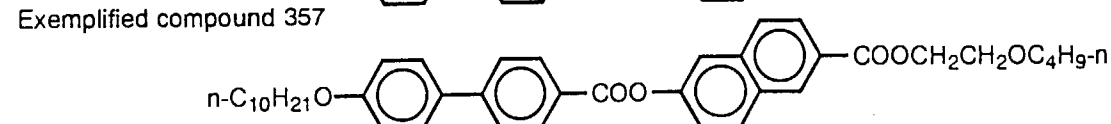
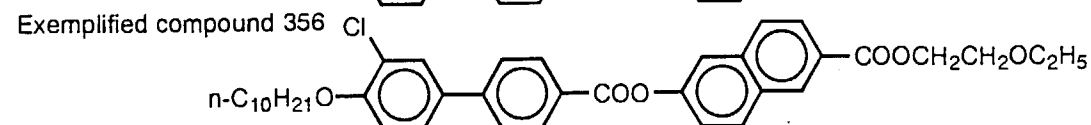
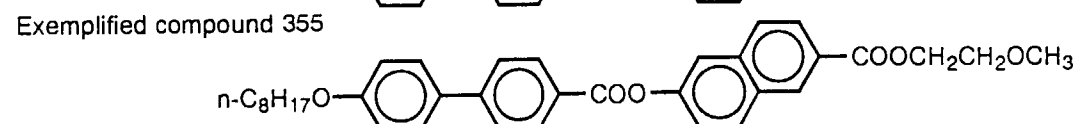
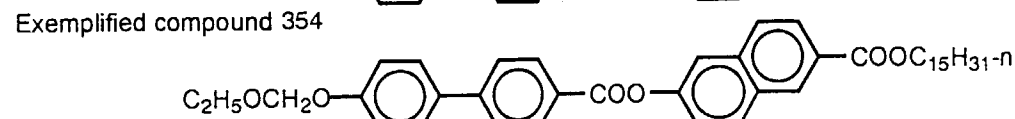
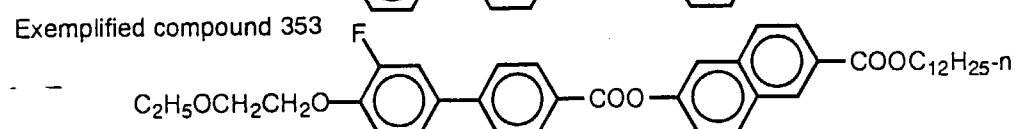
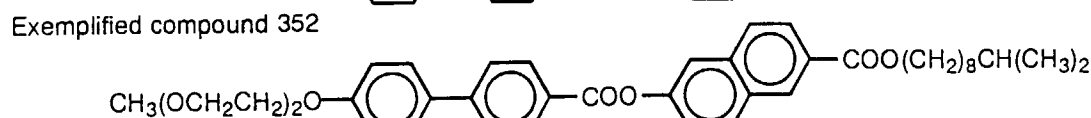
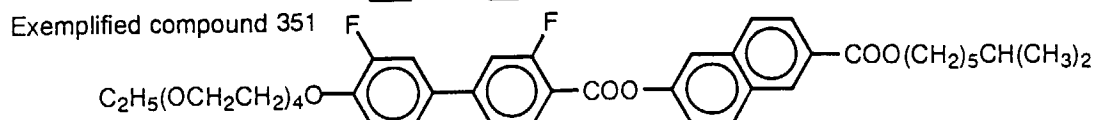
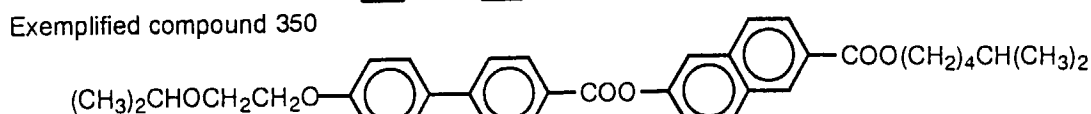
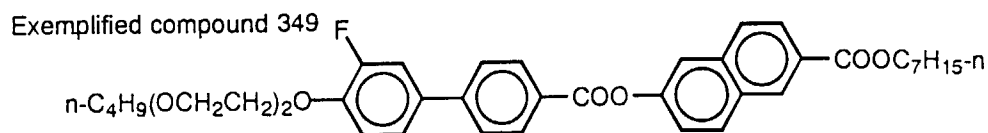
Exemplified compound 335



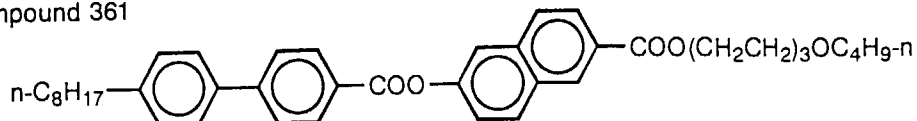
Exemplified compound 336



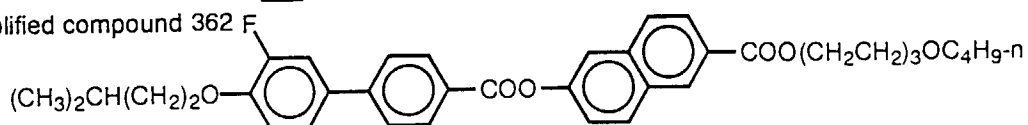




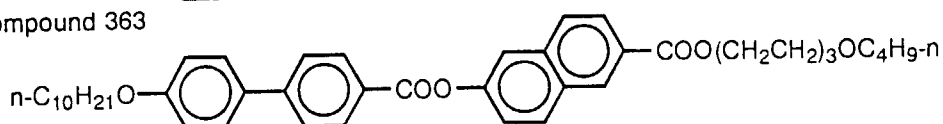
Exemplified compound 361



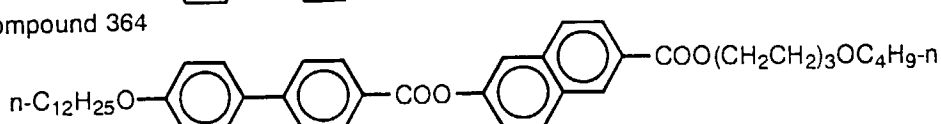
Exemplified compound 362



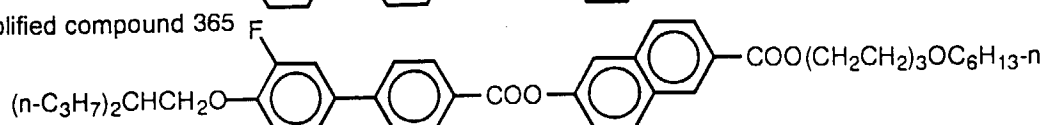
Exemplified compound 363



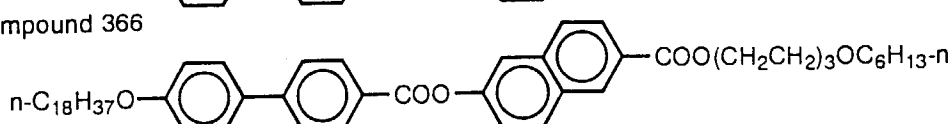
Exemplified compound 364



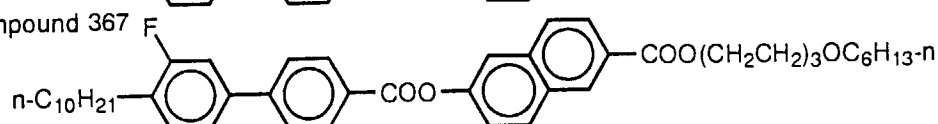
Exemplified compound 365



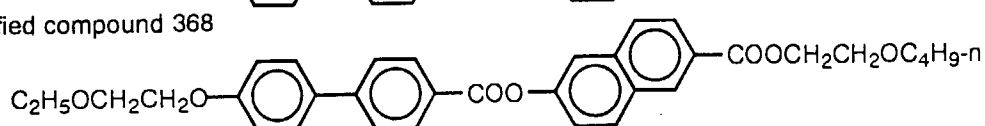
Exemplified compound 366



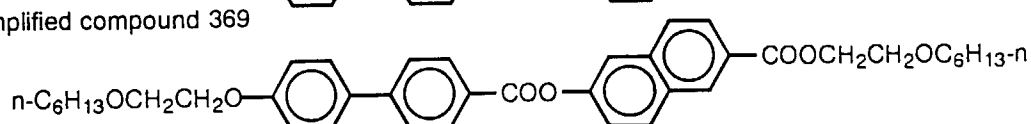
Exemplified compound 367



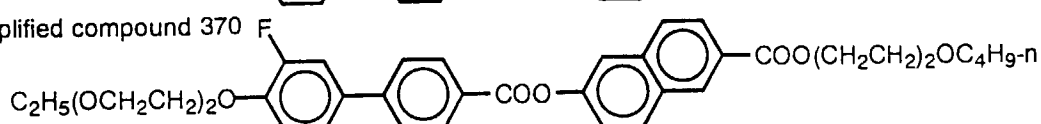
Exemplified compound 368



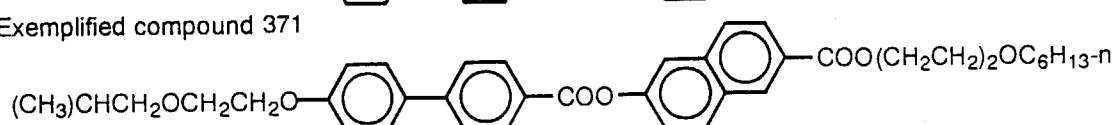
Exemplified compound 369



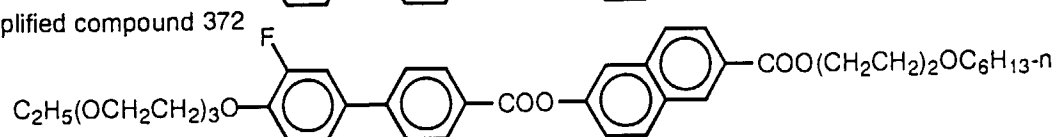
Exemplified compound 370

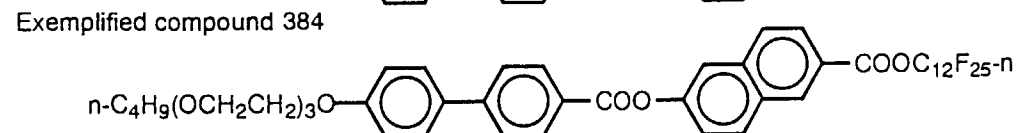
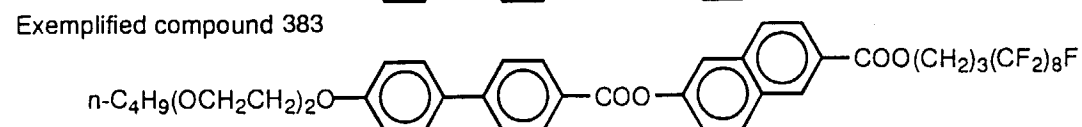
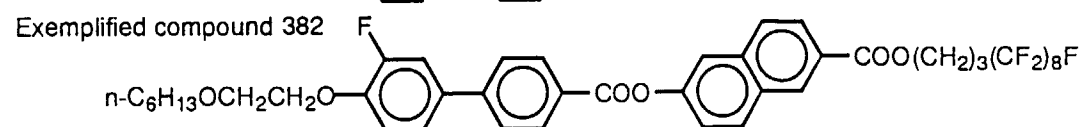
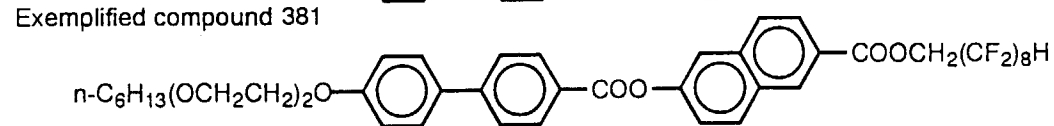
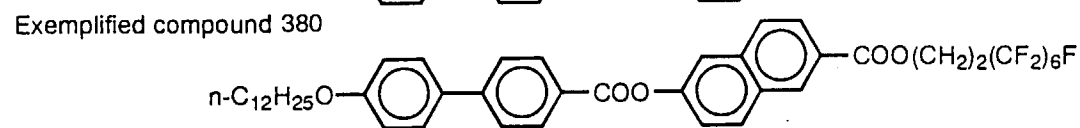
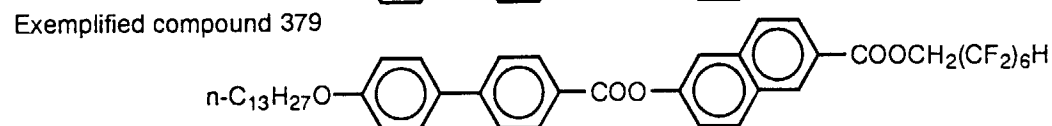
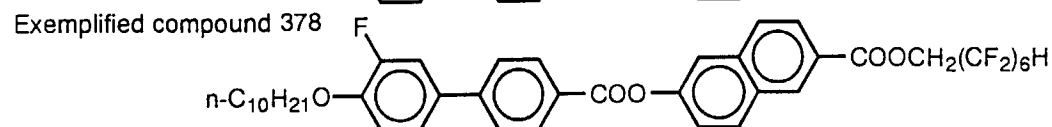
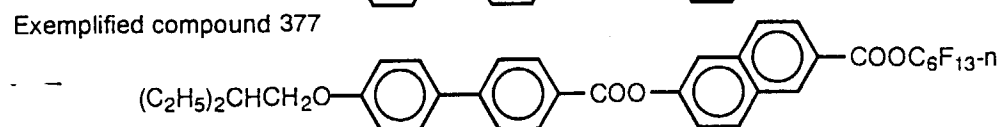
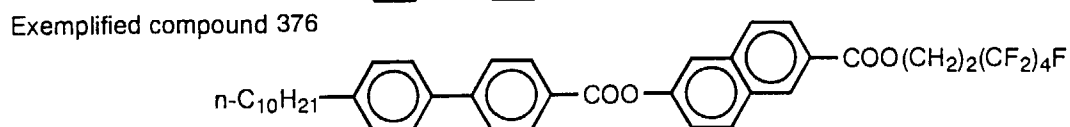
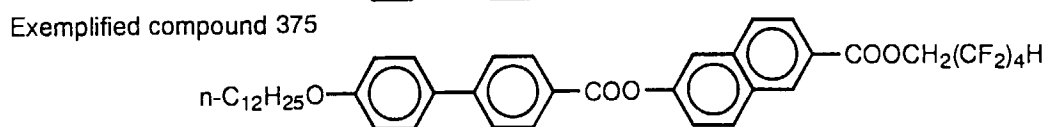
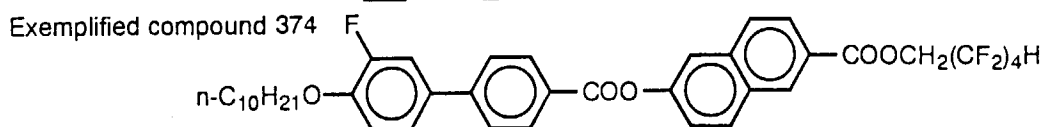
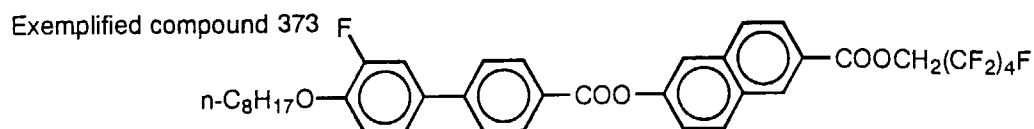


Exemplified compound 371

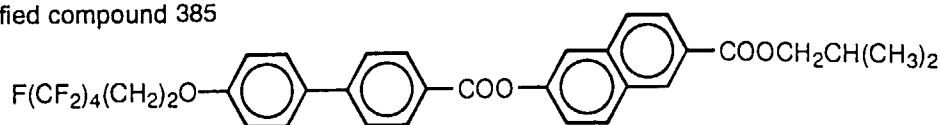


Exemplified compound 372

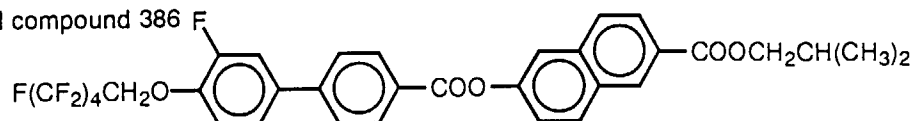




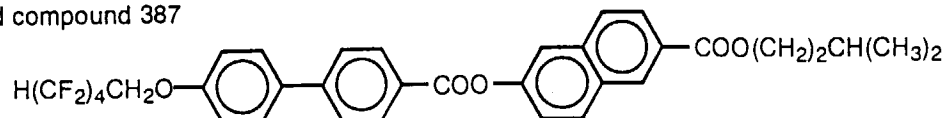
Exemplified compound 385



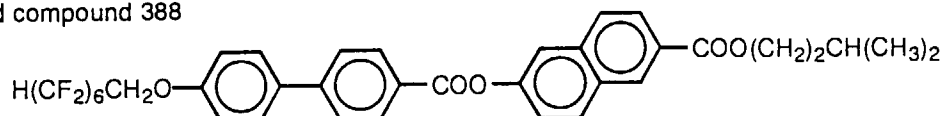
Exemplified compound 386



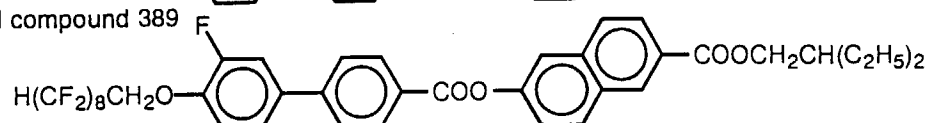
Exemplified compound 387



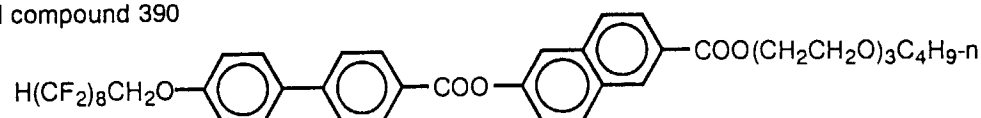
Exemplified compound 388



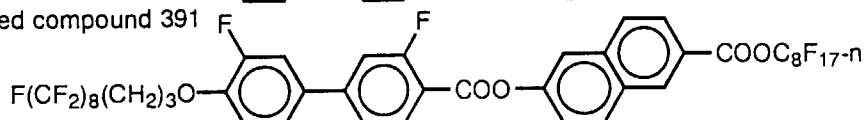
Exemplified compound 389



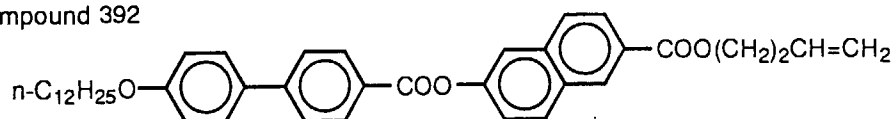
Exemplified compound 390



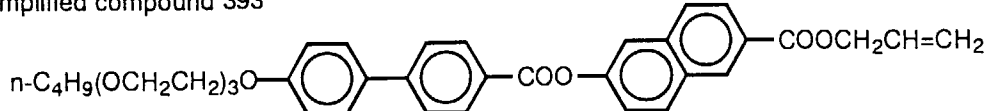
Exemplified compound 391



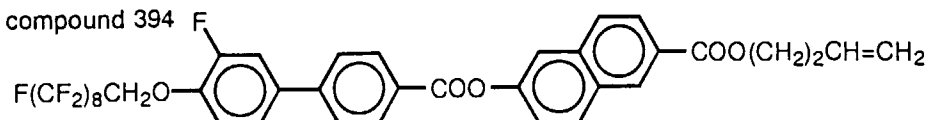
Exemplified compound 392



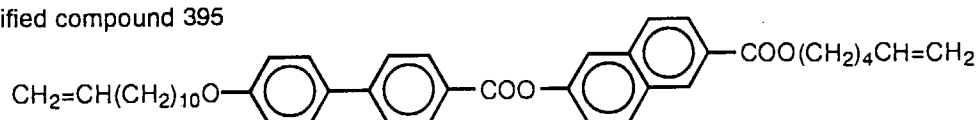
Exemplified compound 393



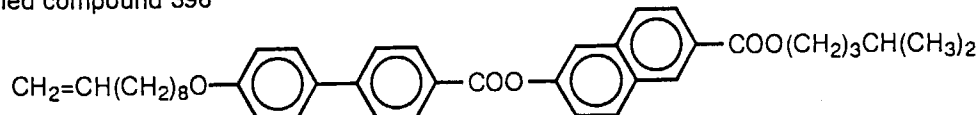
Exemplified compound 394



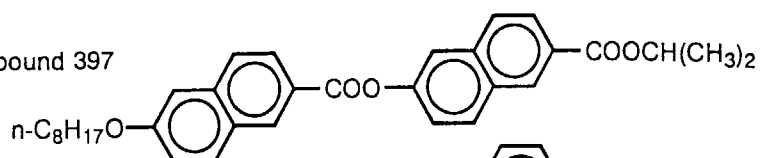
Exemplified compound 395



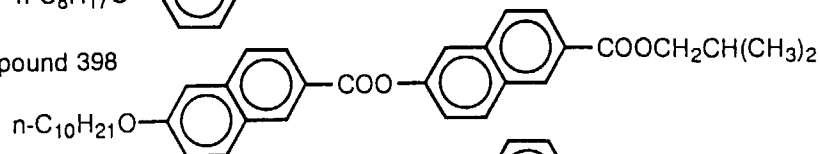
Exemplified compound 396



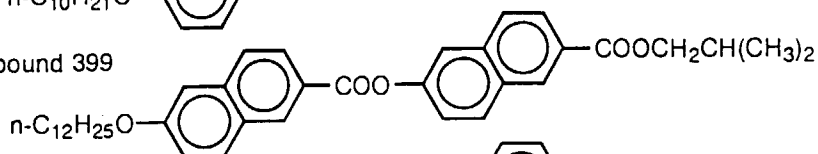
Exemplified compound 397



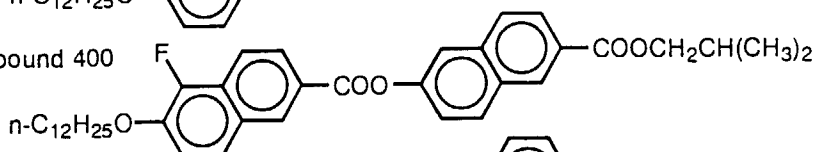
Exemplified compound 398



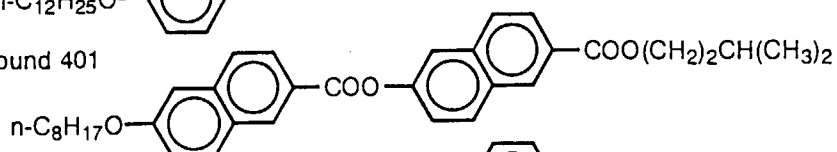
Exemplified compound 399



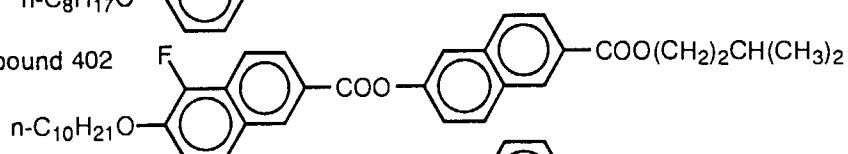
Exemplified compound 400



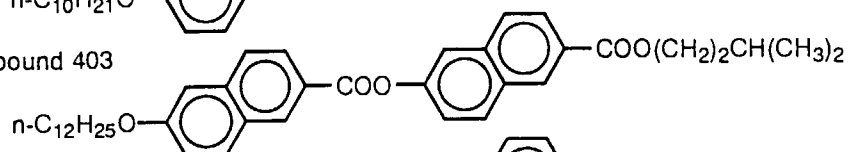
Exemplified compound 401



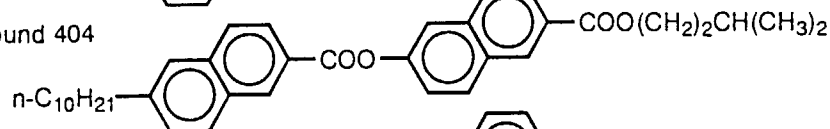
Exemplified compound 402



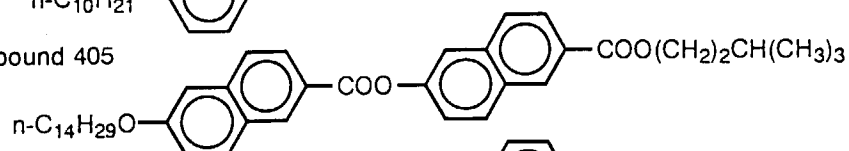
Exemplified compound 403



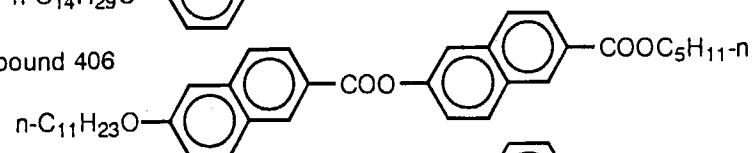
Exemplified compound 404



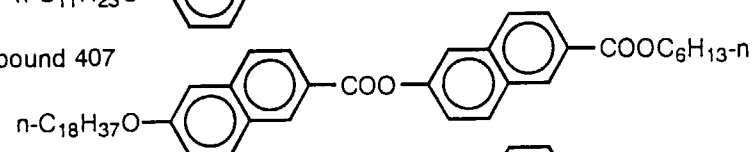
Exemplified compound 405



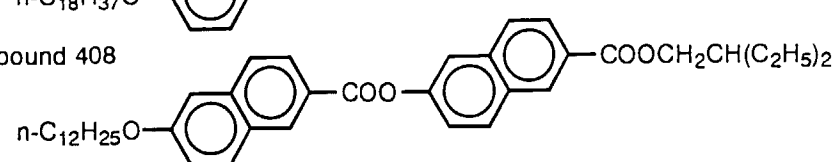
Exemplified compound 406



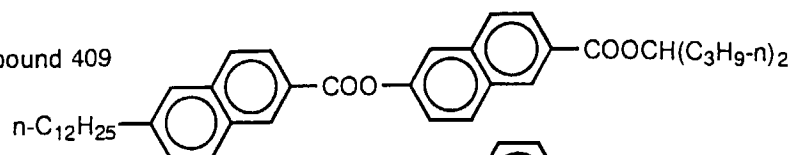
Exemplified compound 407



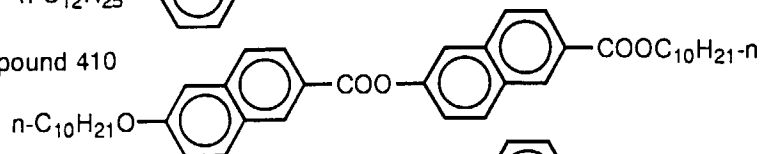
Exemplified compound 408



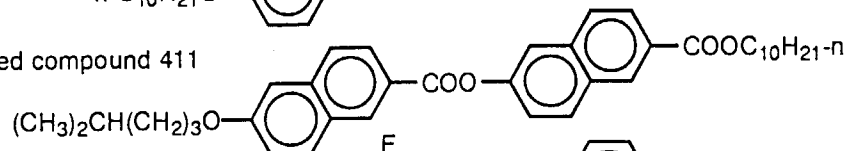
Exemplified compound 409



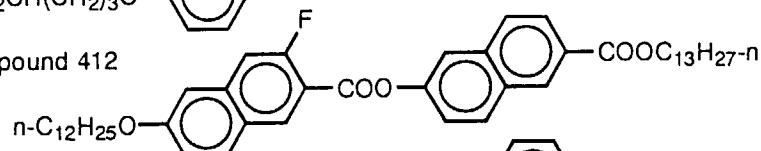
Exemplified compound 410



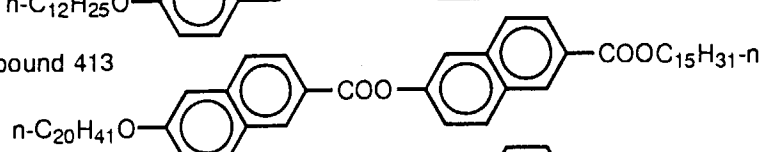
Exemplified compound 411



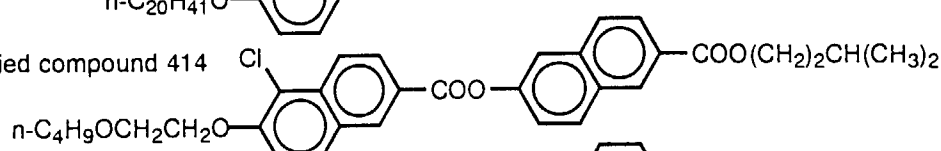
Exemplified compound 412



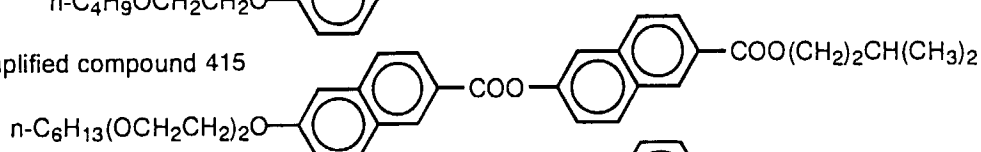
Exemplified compound 413



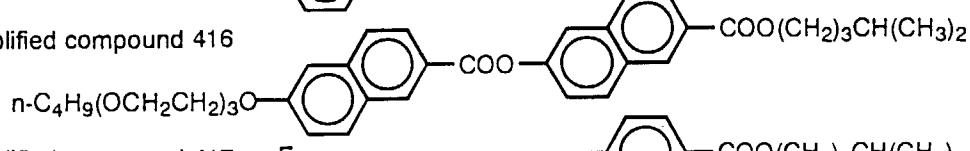
Exemplified compound 414



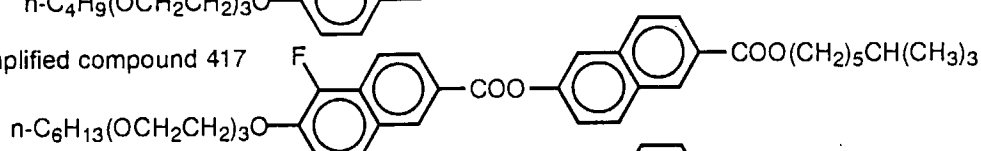
Exemplified compound 415



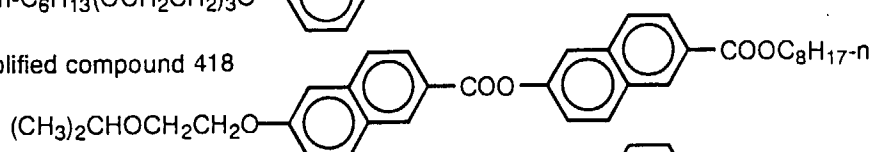
Exemplified compound 416



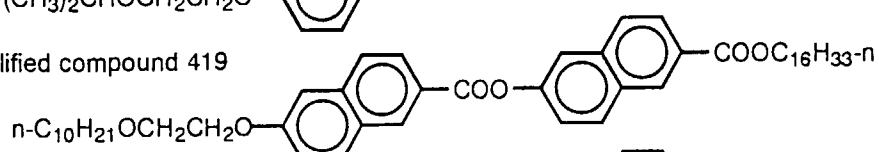
Exemplified compound 417



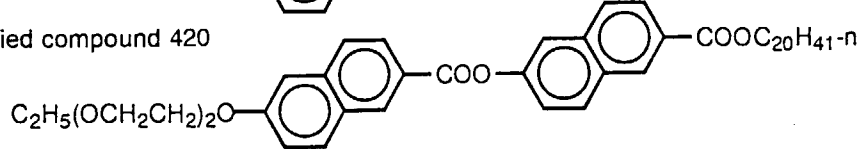
Exemplified compound 418



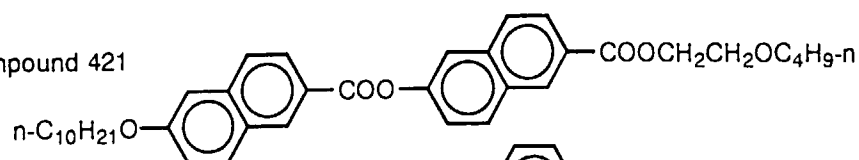
Exemplified compound 419



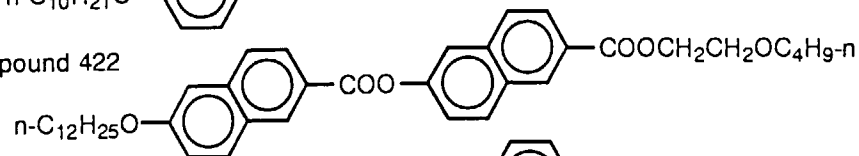
Exemplified compound 420



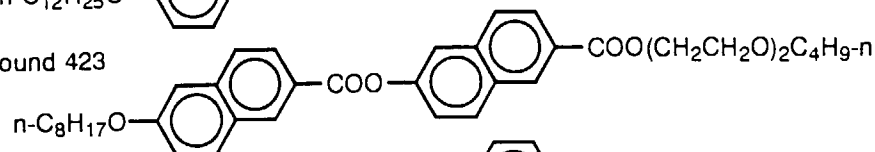
Exemplified compound 421



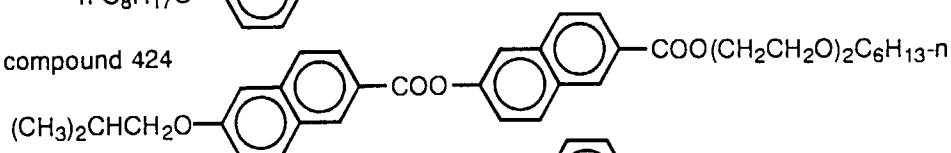
Exemplified compound 422



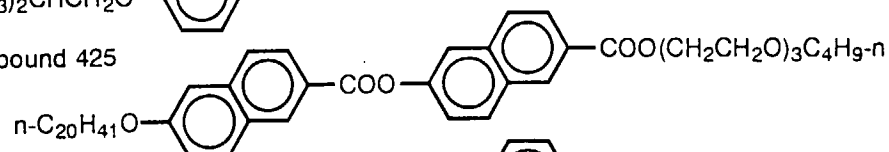
Exemplified compound 423



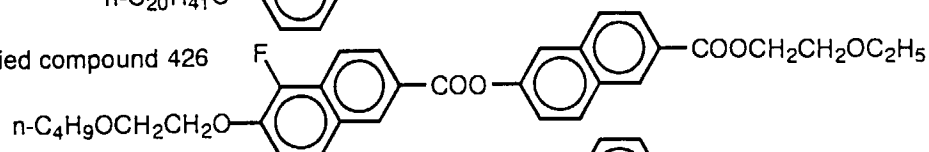
Exemplified compound 424



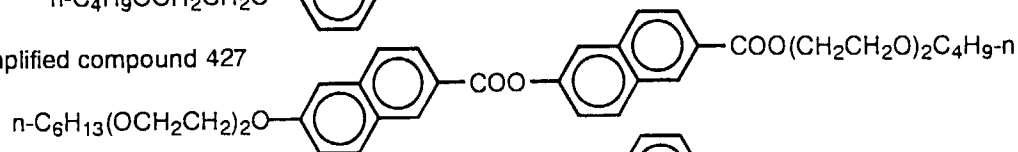
Exemplified compound 425



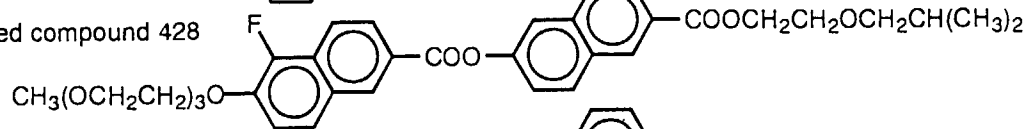
Exemplified compound 426



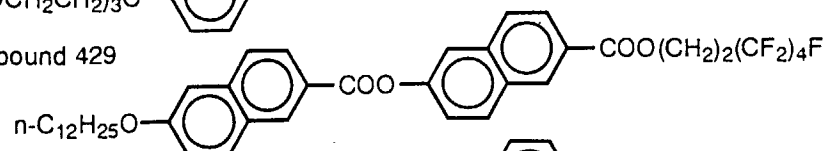
Exemplified compound 427



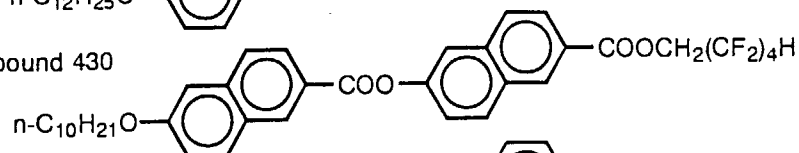
Exemplified compound 428



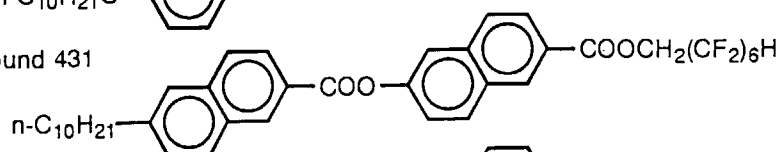
Exemplified compound 429



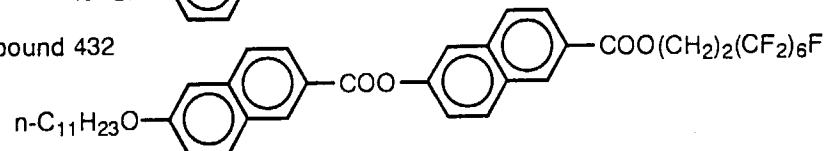
Exemplified compound 430

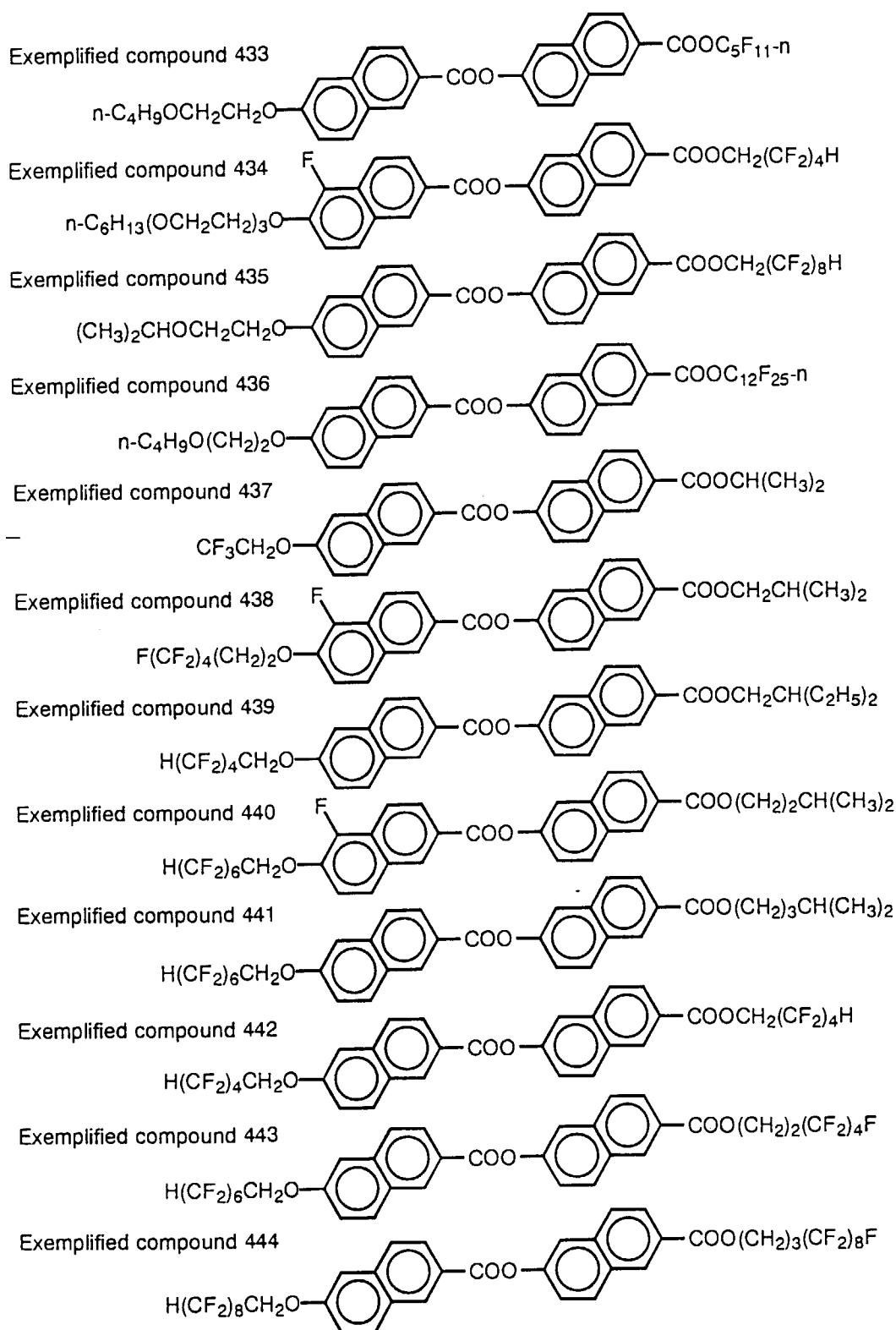


Exemplified compound 431



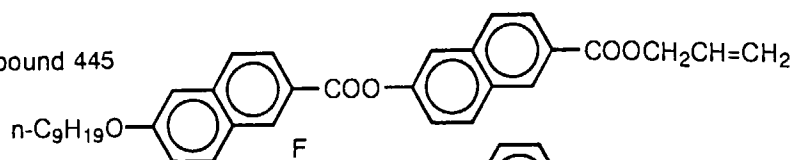
Exemplified compound 432





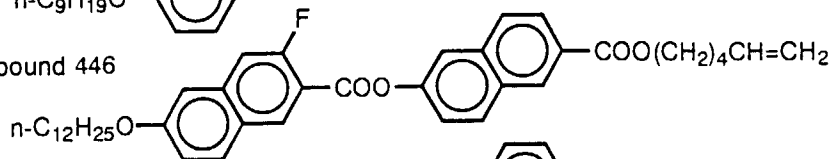
Exemplified compound 445

5



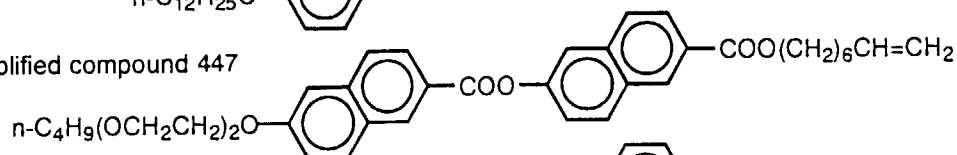
Exemplified compound 446

10

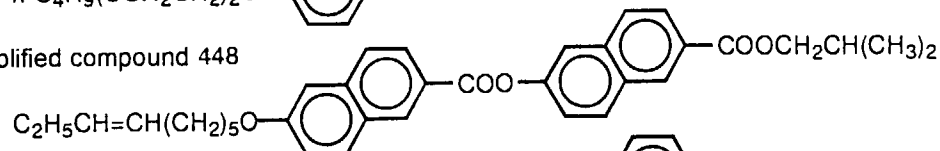


Exemplified compound 447

15

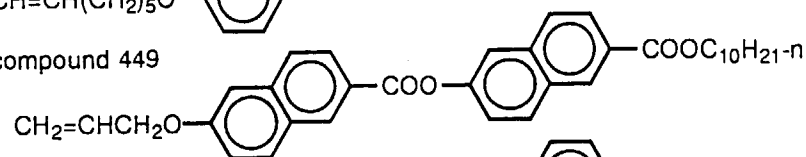


Exemplified compound 448



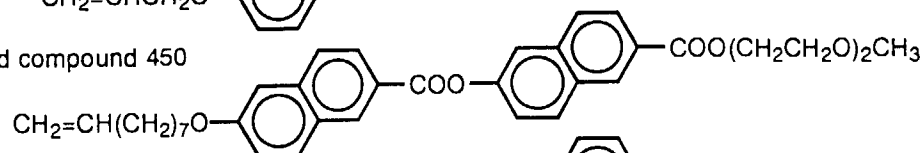
Exemplified compound 449

20



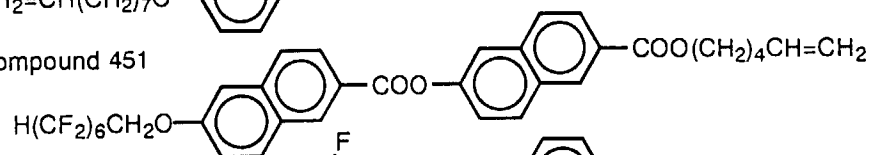
Exemplified compound 450

25



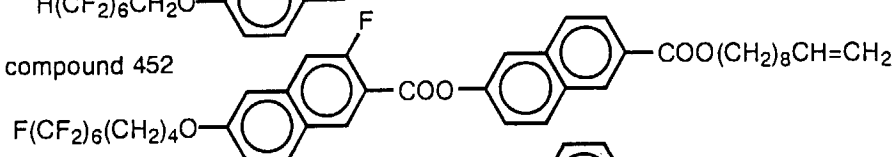
Exemplified compound 451

30

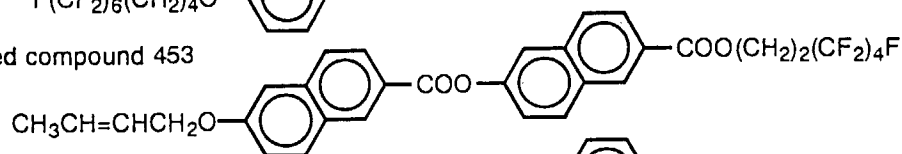


Exemplified compound 452

35

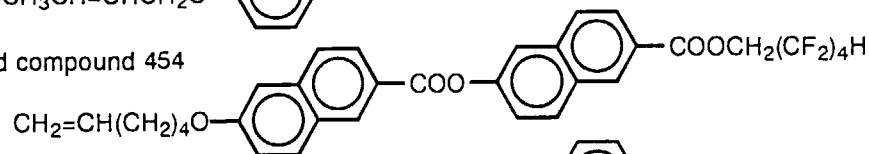


Exemplified compound 453



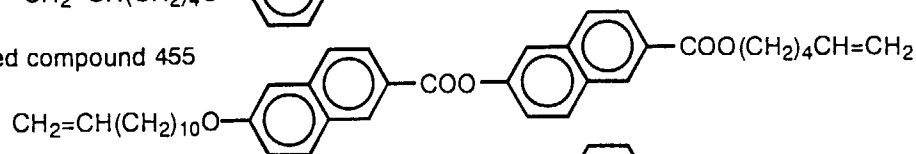
Exemplified compound 454

40



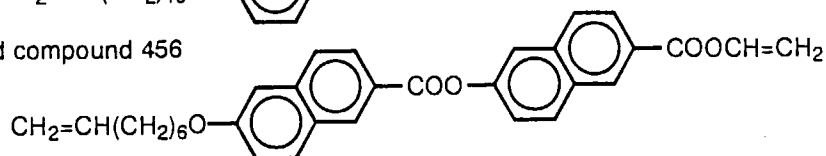
Exemplified compound 455

45



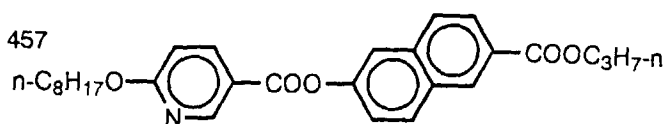
Exemplified compound 456

50

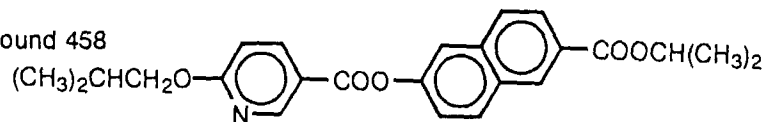


55

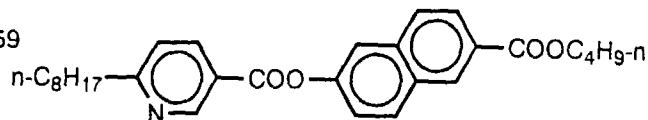
Exemplified compound 457



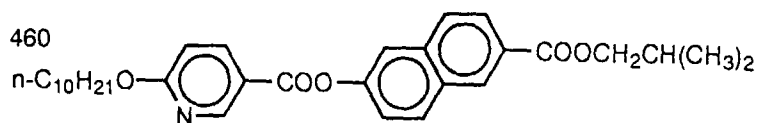
Exemplified compound 458



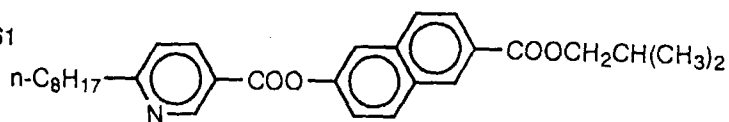
Exemplified compound 459



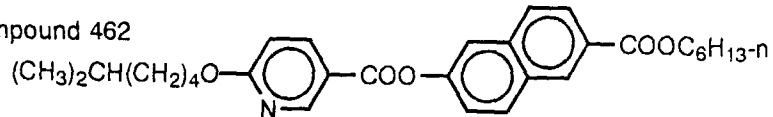
Exemplified compound 460



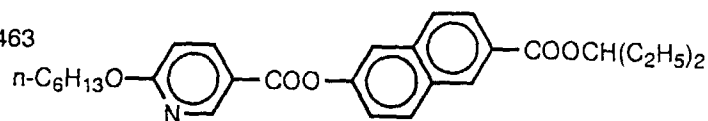
Exemplified compound 461



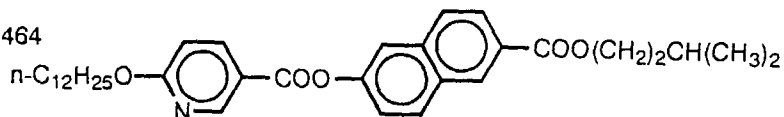
Exemplified compound 462



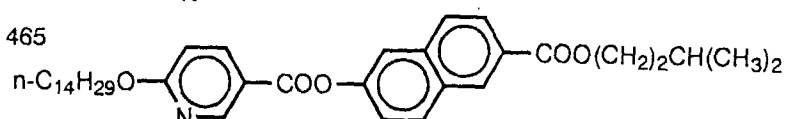
Exemplified compound 463



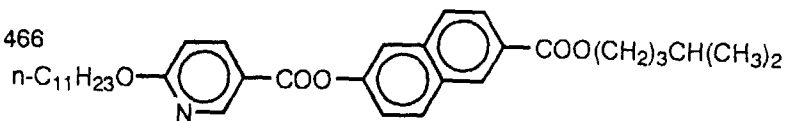
Exemplified compound 464



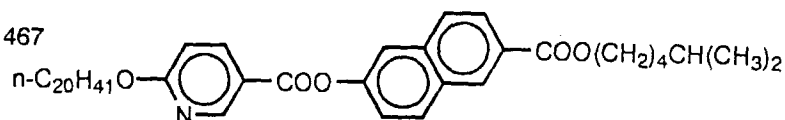
Exemplified compound 465



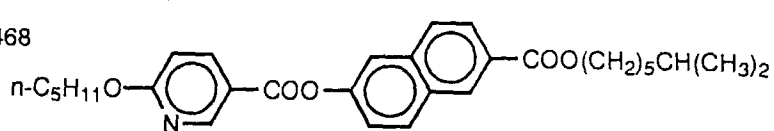
Exemplified compound 466

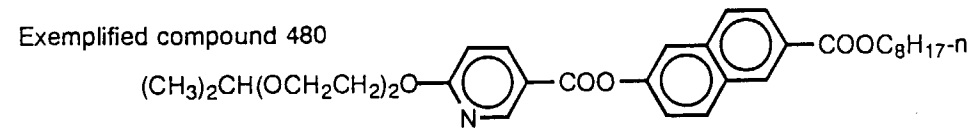
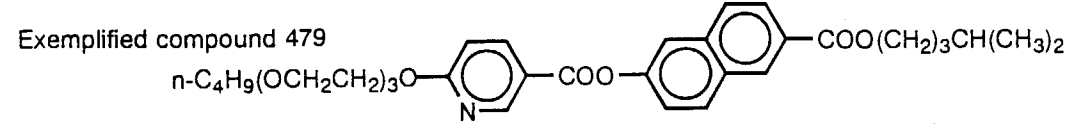
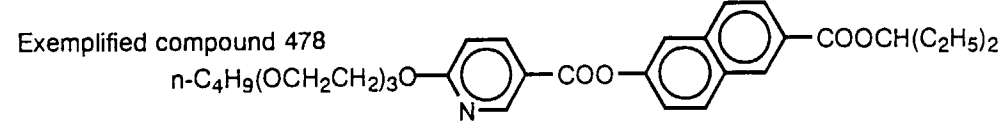
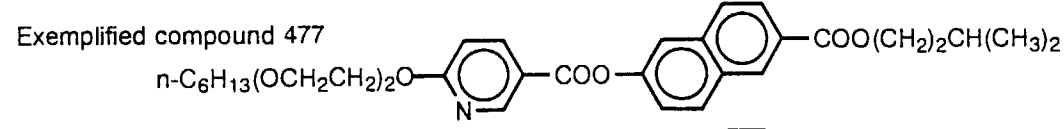
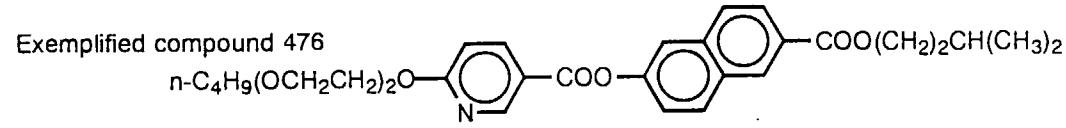
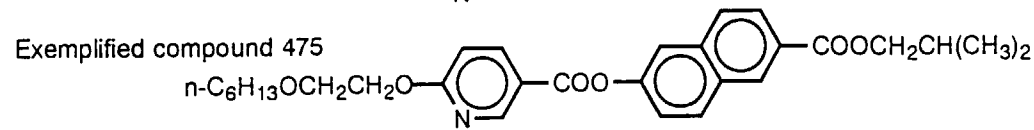
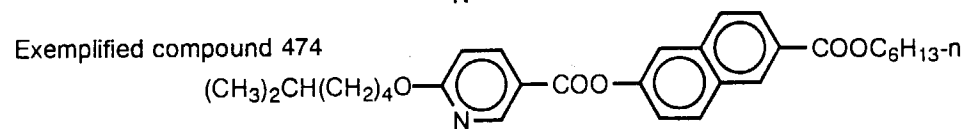
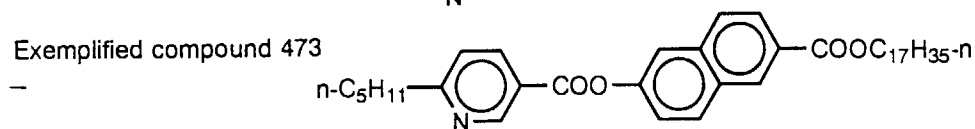
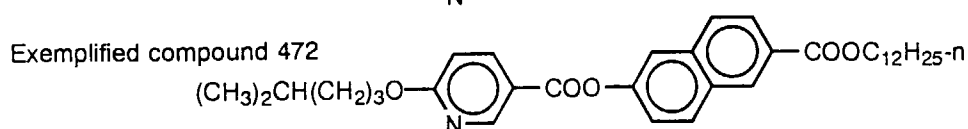
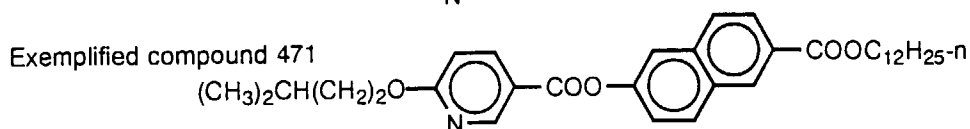
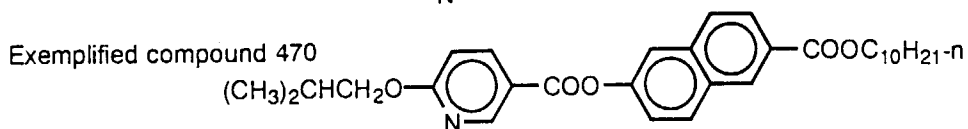
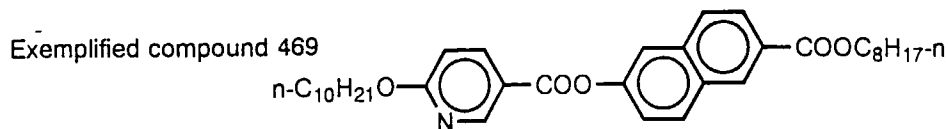


Exemplified compound 467

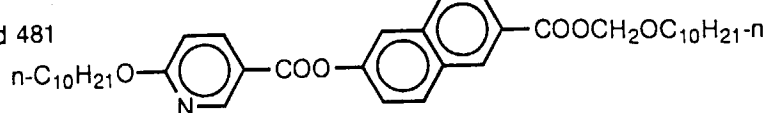


Exemplified compound 468

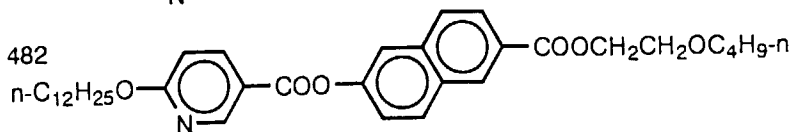




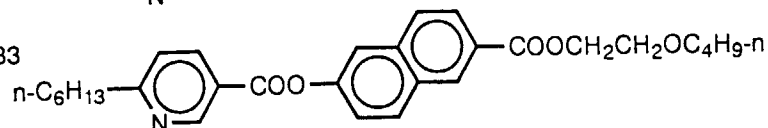
Exemplified compound 481



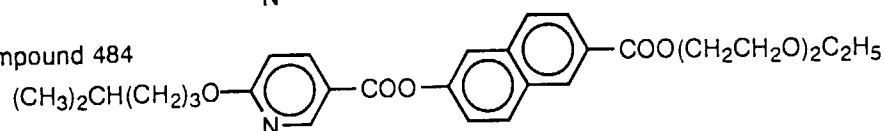
Exemplified compound 482



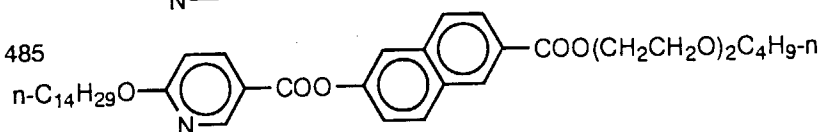
Exemplified compound 483



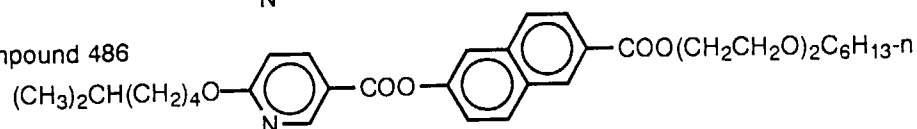
Exemplified compound 484



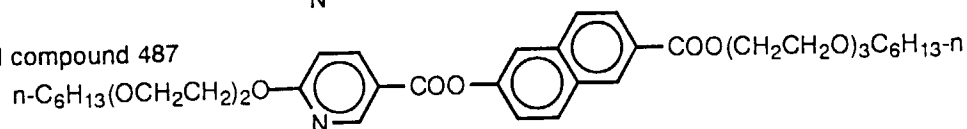
Exemplified compound 485



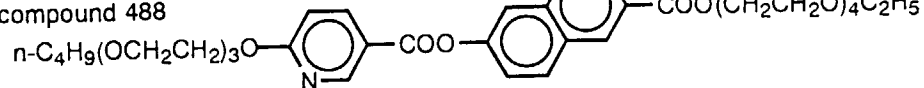
Exemplified compound 486



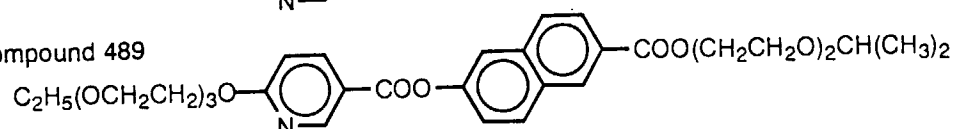
Exemplified compound 487



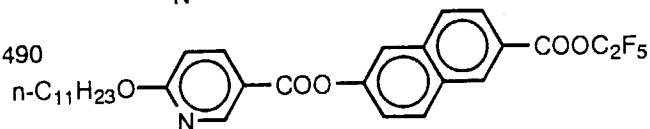
Exemplified compound 488



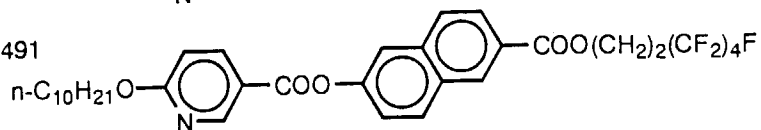
Exemplified compound 489



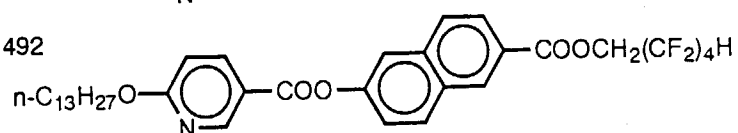
Exemplified compound 490



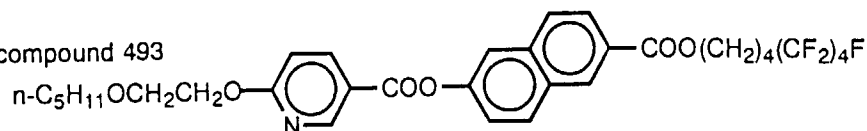
Exemplified compound 491



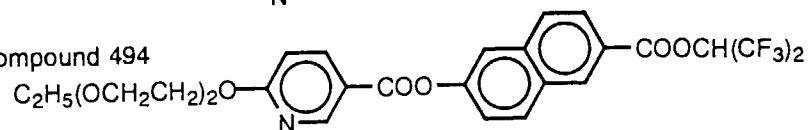
Exemplified compound 492



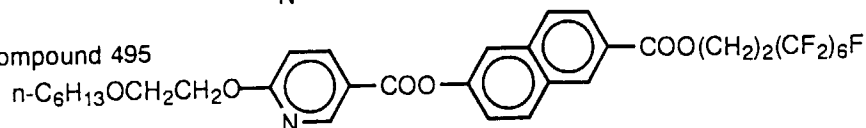
Exemplified compound 493



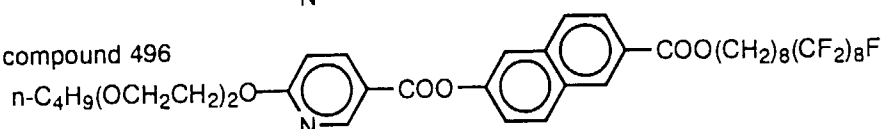
Exemplified compound 494



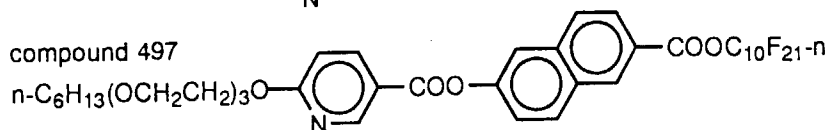
Exemplified compound 495



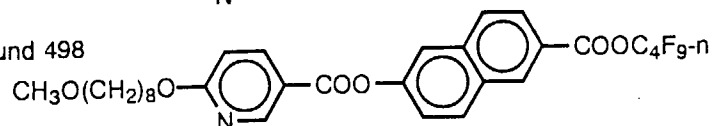
Exemplified compound 496



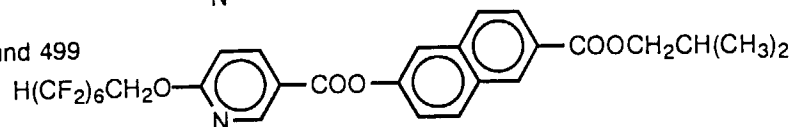
Exemplified compound 497



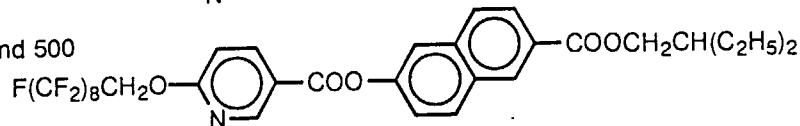
Exemplified compound 498



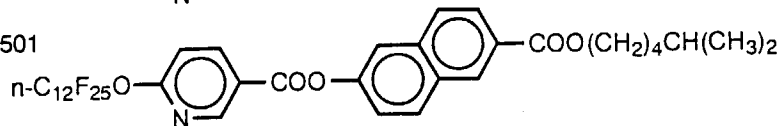
Exemplified compound 499



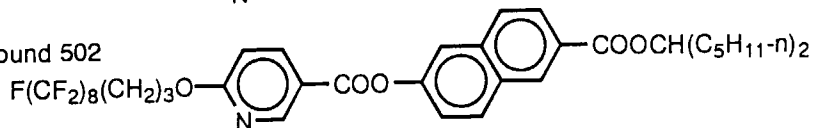
Exemplified compound 500



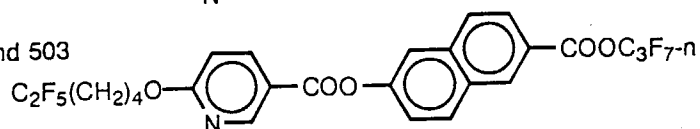
Exemplified compound 501



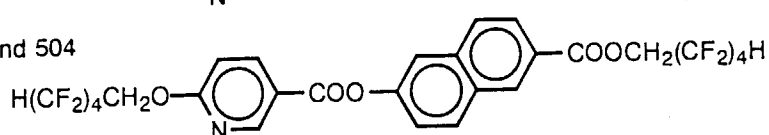
Exemplified compound 502



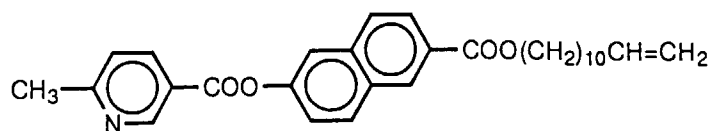
Exemplified compound 503



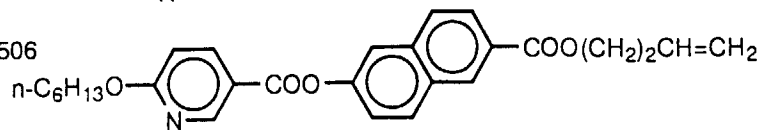
Exemplified compound 504



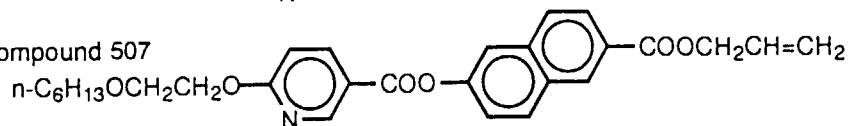
Exemplified compound 505



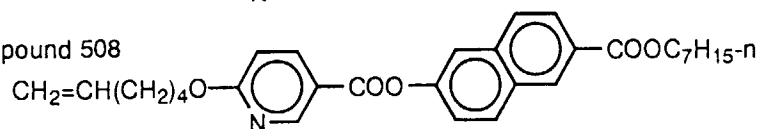
Exemplified compound 506



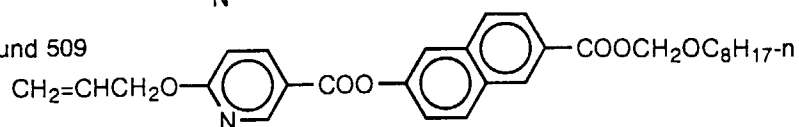
Exemplified compound 507



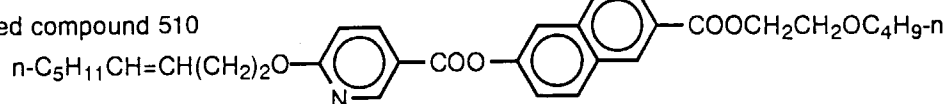
Exemplified compound 508



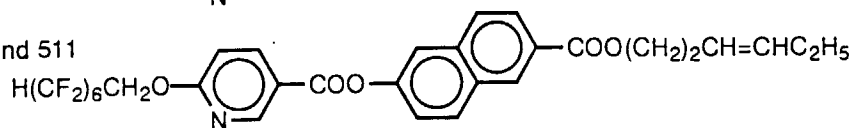
Exemplified compound 509



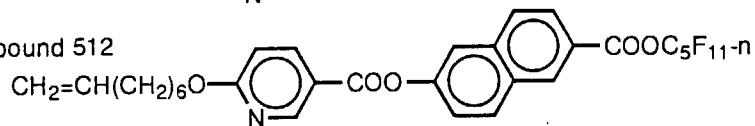
Exemplified compound 510



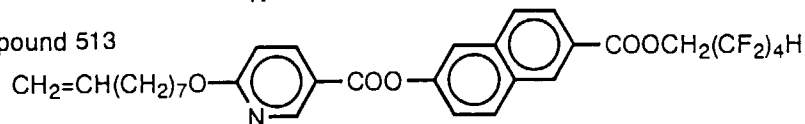
Exemplified compound 511



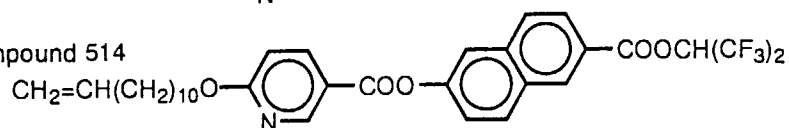
Exemplified compound 512



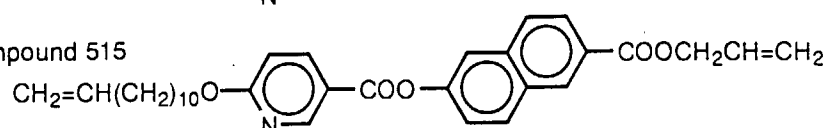
Exemplified compound 513



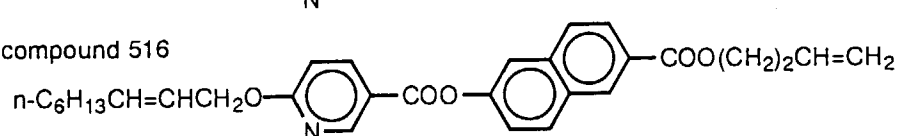
Exemplified compound 514



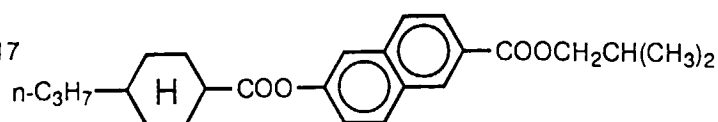
Exemplified compound 515



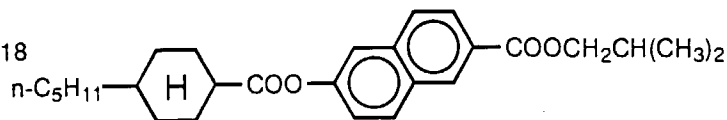
Exemplified compound 516



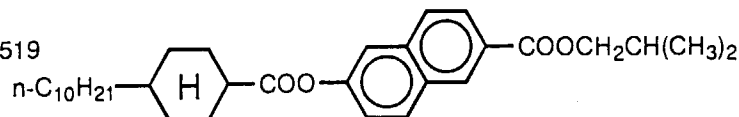
Exemplified compound 517



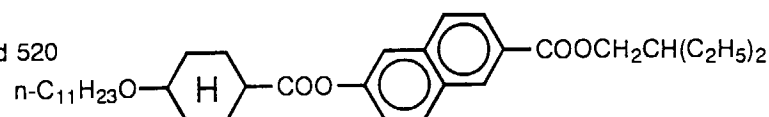
Exemplified compound 518



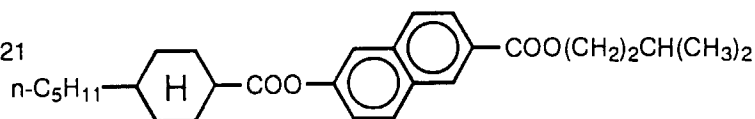
Exemplified compound 519



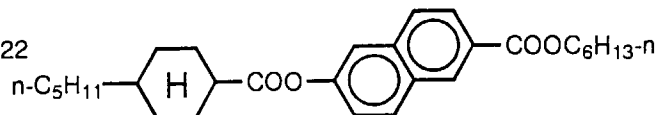
Exemplified compound 520



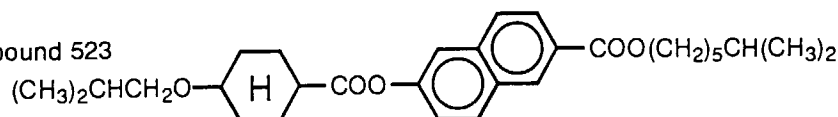
Exemplified compound 521



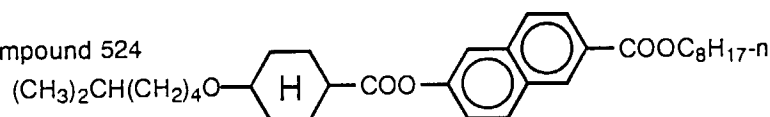
Exemplified compound 522



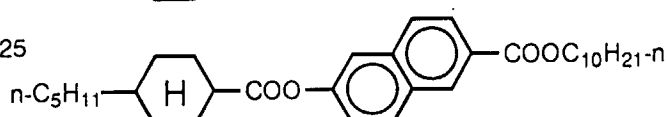
Exemplified compound 523



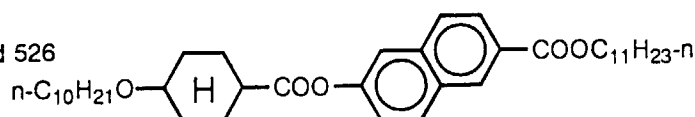
Exemplified compound 524



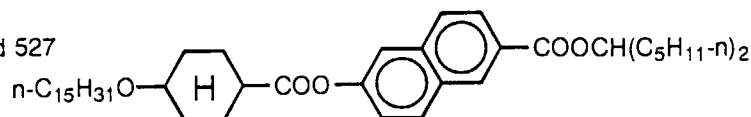
Exemplified compound 525



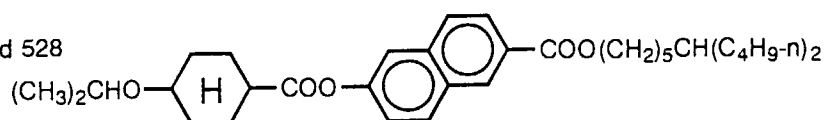
Exemplified compound 526



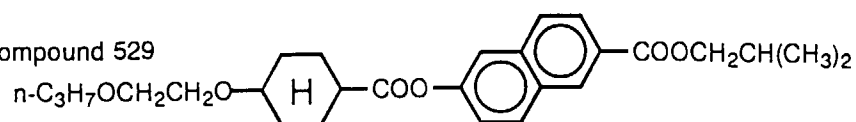
Exemplified compound 527



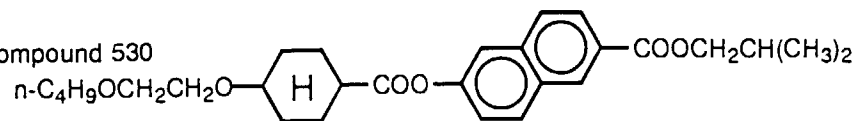
Exemplified compound 528



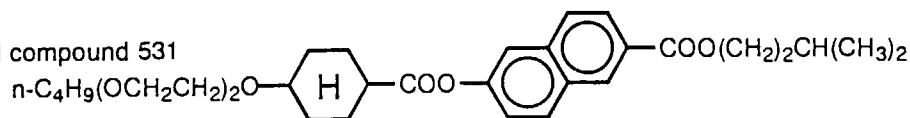
Exemplified compound 529



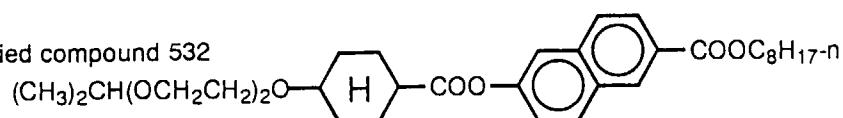
Exemplified compound 530



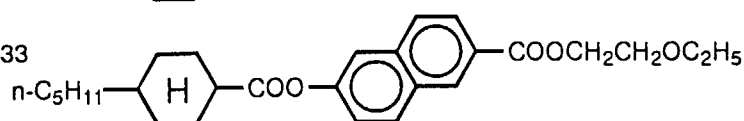
Exemplified compound 531



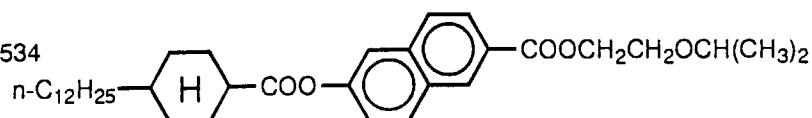
Exemplified compound 532



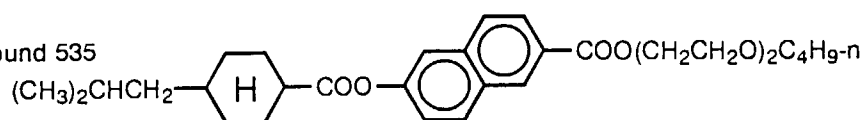
Exemplified compound 533



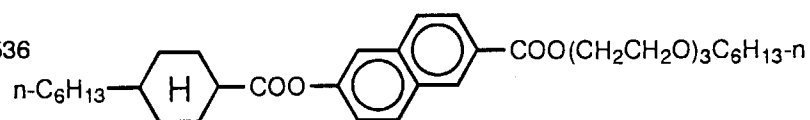
Exemplified compound 534



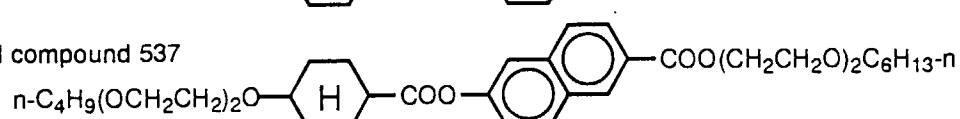
Exemplified compound 535



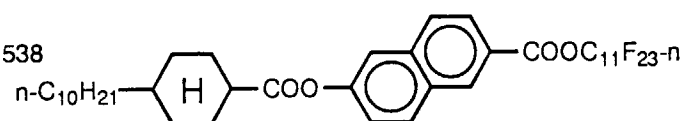
Exemplified compound 536



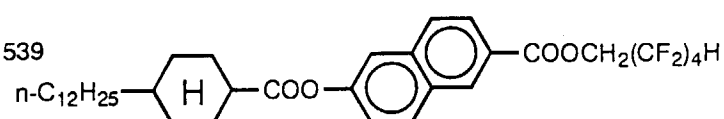
Exemplified compound 537



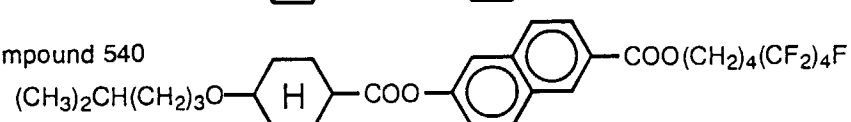
Exemplified compound 538

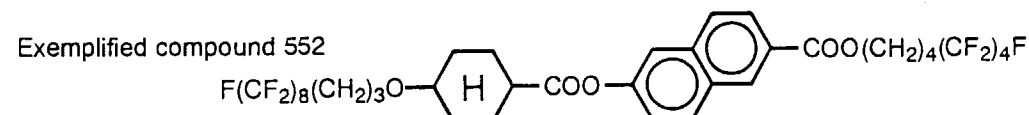
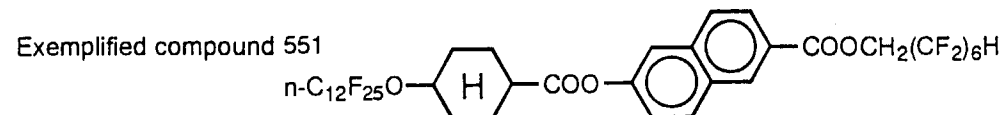
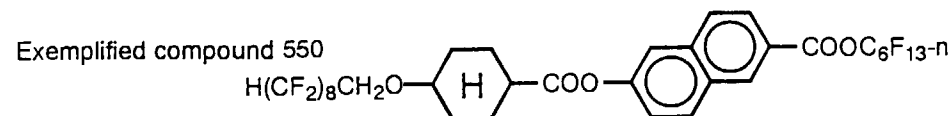
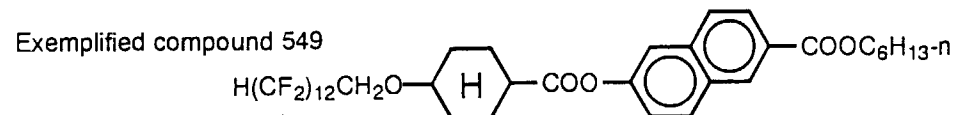
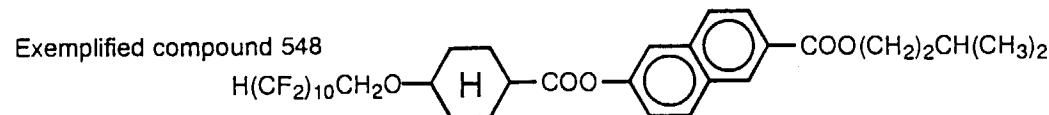
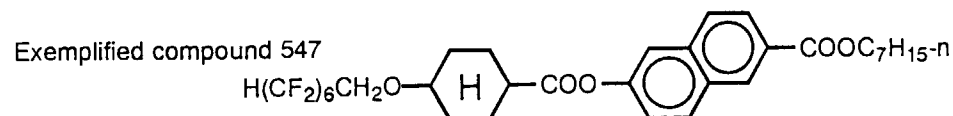
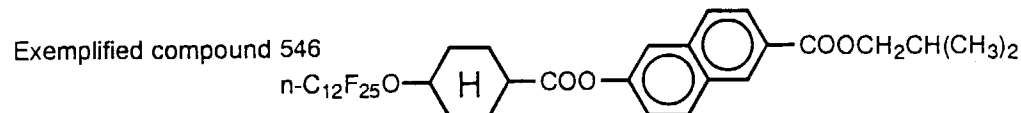
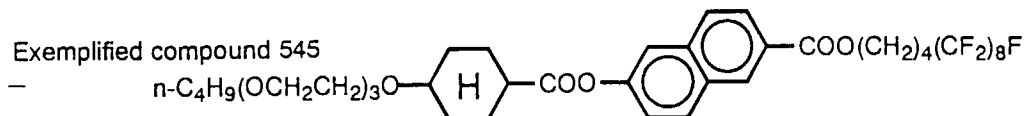
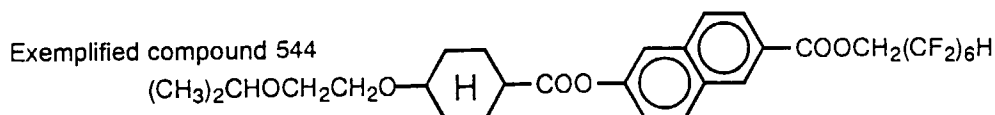
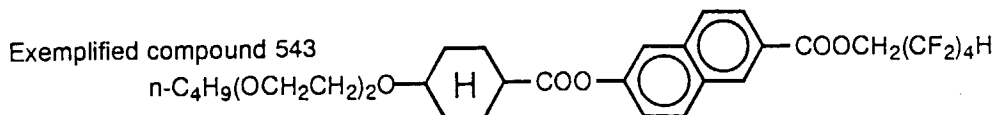
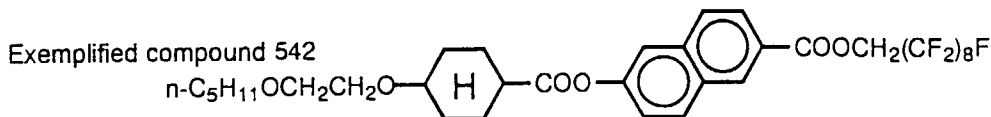
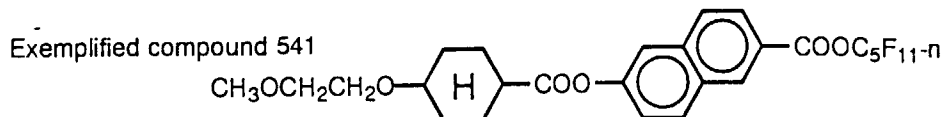


Exemplified compound 539

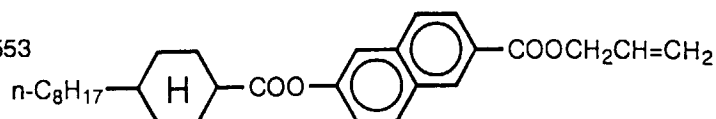


Exemplified compound 540

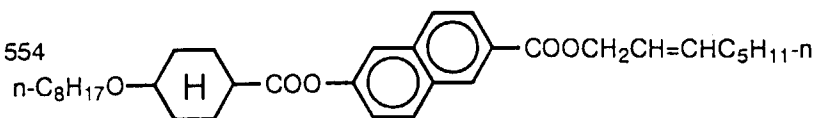




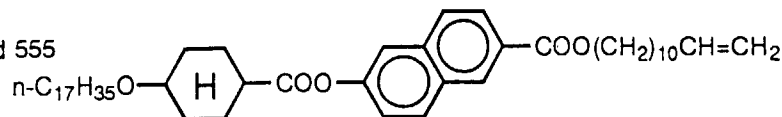
Exemplified compound 553



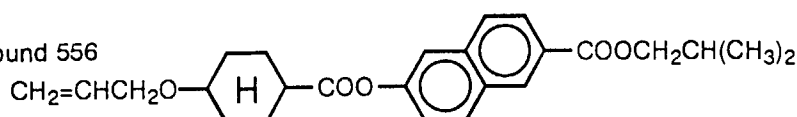
Exemplified compound 554



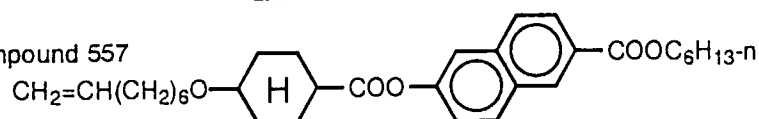
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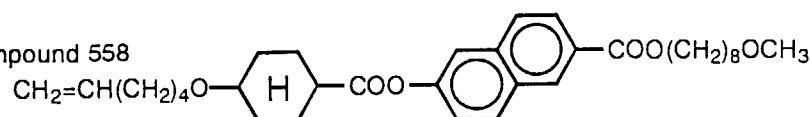
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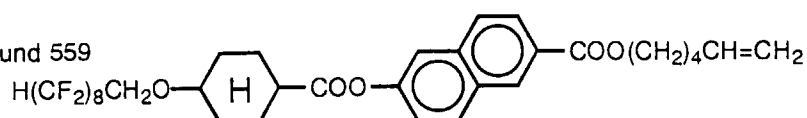
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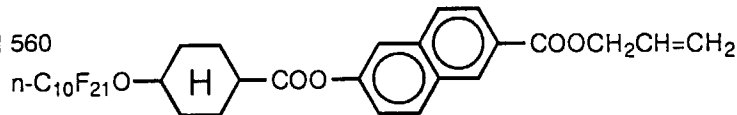
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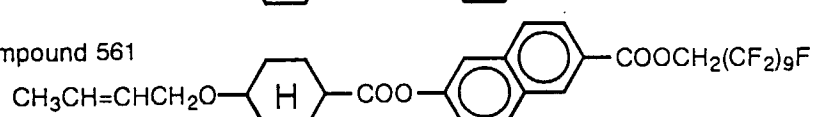
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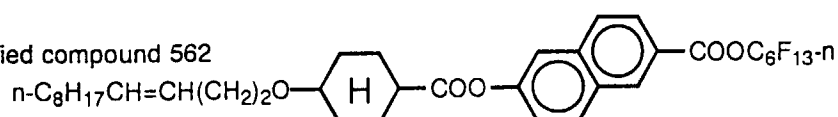
Exemplified compound 560



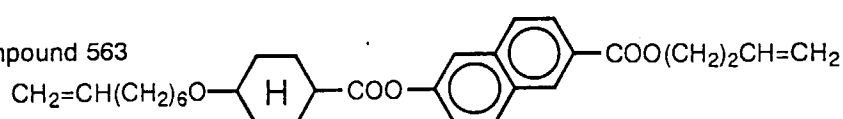
Exemplified compound 561



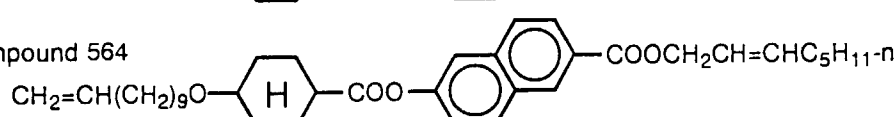
Exemplified compound 562



Exemplified compound 563

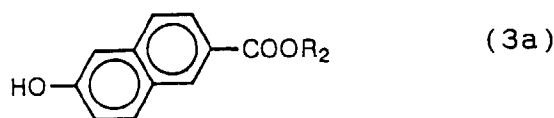


Exemplified compound 564



The compound represented by Formula (1) can be produced typically by the following method.

That is, the above compound can be produced by carrying out esterification using a compound represented by Formula (3a) and a compound represented by Formula (4):



wherein R_1 , R_2 , A and z are synonymous with those described above.

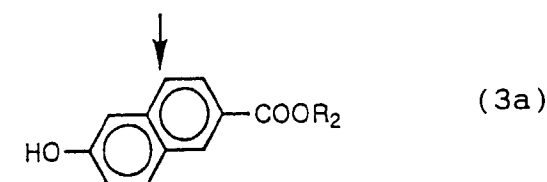
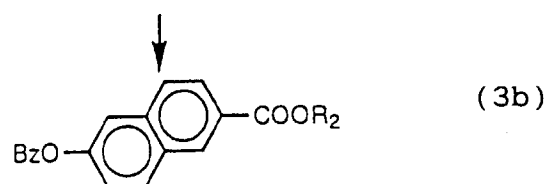
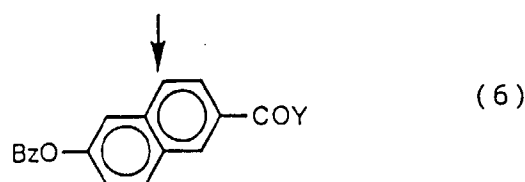
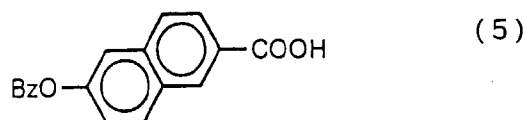
There can be applied as a method for carrying out the esterification, known methods, for example, (1) a method in which the compound represented by Formula (3a) is reacted with the compound represented by Formula (4) by the action of a condensing agent such as N,N'-dicyclohexylcarbodiimide (DCC) in the presence of a catalyst such as, for example, 4-pyrrolidinopyridine and 4-N,N-dimethylaminopyridine, or (2) a method in which the compound represented by Formula (4) is reacted with thionyl chloride or oxalyl chloride to prepare the halide, and then the compound represented by Formula (3a) is reacted therewith.

Some of the compounds represented by Formula (4) are commercially available. Further, they can be produced by known methods [for example, J. Chem. Soc., 1874 (1935), J. Chem. Soc., 2556 (1954), J. Chem. Soc., 1412 (1955), J. Chem. Soc., 393 (1957) and J. Chem. Soc., 1545 (1959)].

That is, a 4-alkoxybenzoic acid derivative can be produced by reacting, for example, a 4-hydroxybenzoic acid derivative with an alkylating agent such as an alkyl halide and an alkyl tosylate in the presence of a base.

Further, a 4-alkoxybiphenyl-4'-carboxylic acid derivative can be produced by reacting a 4-hydroxybiphenyl-4'-carboxylic acid derivative with an alkylating agent such as an alkyl halide and an alkyl tosylate in the presence of a base.

The compounds represented by Formulas (3a) or (3b) can be produced typically through the following steps:



wherein R_2 is synonymous with that described above; Y represents a halogen atom; and Bz represents a benzyl group.

That is, 2-benzyloxy-6-naphthoic acid represented by Formula (5) produced by benzylation of 2-hydroxy-6-naphthoic acid with a benzyl halide is reacted with thionyl chloride or oxalyl chloride to produce an acid halide represented

by Formula (6). Then, the acid halide represented by Formula (6) is reacted with an alcoholic compound represented by Formula (7):



wherein R_2 is synonymous with that described above, whereby the compound represented by Formula (3b) can be produced.

Further, the compound represented by Formula (3b) can be produced as well by reacting 2-benzyloxy-6-naphthoic acid represented by Formula (5) with the alcoholic compound represented by Formula (7) by the action of a condensing agent such as N,N'-dicyclohexylcarbodiimide (DCC) in the presence of a catalyst such as, for example, 4-pyrrolidinopyridine and 4-N,N-dimethylaminopyridine.

Further, the compound represented by Formula (3b) can be produced as well by reacting 2-benzyloxy-6-naphthoic acid represented by Formula (5) with an alkylating agent represented by Formula (8) in the presence of an aprotic polar solvent and an alkaline metal salt:



wherein R_2 is synonymous with that described above, and W represents a halogen atom or a leaving group such as an arylsulfonyloxy group.

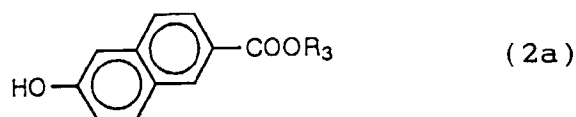
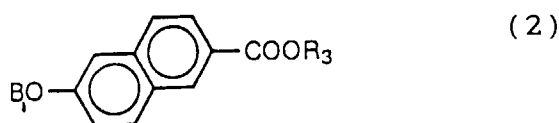
Then, the compound represented by Formula (3a) can be produced by hydrogenation (debenzylation) the compound represented by Formula (3b).

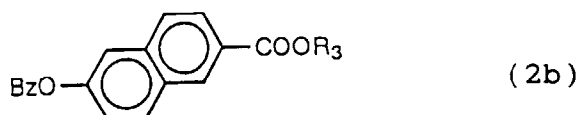
The hydrogenation can be carried out by known methods. That is, the hydrogenation can be done by carrying out hydrogenation in an organic solvent (for example, alcoholic solvents and ester solvents) at a pressure of atmospheric pressure to about 50 kg/cm² in the presence of a catalyst prepared by carrying metals such as, for example, Pd, Pt, Rh, Co and Ni on activated carbon, alumina, barium sulfate, or the like. In general, the hydrogenation is carried out at 0 to 200°C, preferably 10 to 150°C.

Further, the compound represented by Formula (3a) can be produced as well by reacting 2-hydroxy-6-naphthoic acid with an alkylating agent represented by Formula (8) in the presence of an aprotic polar solvent and an alkaline metal salt.

2-Hydroxy-6-naphthoic acid can be produced by known methods [for example, a method described in J. Chem. Soc., 678 (1954)].

Among the naphthalene compounds represented by (3a) and (3b), the naphthalene compounds represented by Formula (2), that is, the compounds represented by Formula (2a) and (2b) are novel compounds, and the present invention provides these compounds.





In Formula (2), B₁ represents a hydrogen atom or a benzyl group, and in formula (2b), Bz represents a benzyl group.

In Formulas (2a) and (2b), R₃ represents a branched alkyl group having no asymmetric carbon atoms and having 3 to 20 carbon atoms, or a linear or branched alkyl group having 1 to 20 carbon atoms, an alkoxyalkyl group having 2 to 20 carbon atoms or an alkenyl group having 2 to 20 carbon atoms which are substituted with halogen atoms and have no asymmetric carbon atoms, preferably the branched alkyl group represented by Formula (II), the alkoxyalkyl group represented by Formula (III), or the halogenated alkyl group represented by Formula (IV), (V) or (VI), each described above.

There can be given as the concrete examples of R₃, the branched alkyl groups, halogenated alkyl groups, alkoxy-alkyl groups, halogenated alkoxyalkyl groups, and alkenyl groups, each given as the concrete examples of R₁ and R₂ in Formula (1).

Many of the compounds thus prepared and represented by Formula (1) has intrinsically liquid crystallinity and is useful for constituting a liquid crystal composition and a liquid crystal element using said liquid crystal composition.

The naphthalene compounds of the present invention include compounds showing liquid crystallinity in itself and compounds showing no liquid crystallinity in itself. Further, the naphthalene compounds showing liquid crystallinity include compounds showing a smectic C phase and compounds showing liquid crystallinity but no smectic C phase. These compounds each can effectively be used as components for liquid crystal compositions.

Next, the liquid crystal composition of the present invention will be explained.

In general, a liquid crystal composition comprises two or more kinds of components. The liquid crystal composition of the present invention contains at least one naphthalene compound of the present invention as an essential component.

The naphthalene compound of the present invention used for the liquid crystal composition of the present invention includes naphthalene compounds showing no liquid crystallinity, compounds showing a smectic C phase, and naphthalene compounds showing liquid crystallinity but no smectic C phase.

The liquid crystal composition of the present invention shall not specifically be restricted and includes, for example, liquid crystal compositions showing a smectic phase and liquid crystal compositions showing a chiral smectic phase, preferably liquid crystal compositions showing smectic C, F, G, H and I phases, and liquid crystal compositions showing chiral smectic C, F, G, H and I phases, more preferably liquid crystal compositions showing a chiral smectic C phase.

The liquid crystal composition showing a smectic C phase contains at least one compound represented by Formula (1) and can contain, as an optional component, compounds showing a smectic C phase other than the compound represented by Formula (1), for example, liquid crystal compounds such as phenylbenzoate series liquid crystal compounds, biphenylbenzoate series liquid crystal compounds, naphthalene series liquid crystal compounds, phenylnaphthalene series liquid crystal compounds, phenylpyrimidine series liquid crystal compounds, naphthylpyrimidine series liquid crystal compounds and tolan series liquid crystal compounds. Further, a compound showing no smectic C phase in itself may be contained, if desired.

The content of at least one compound represented by Formula (1) in the compositions showing smectic C phases shall not specifically be restricted and is usually 1 to 100 weight %, preferably 2 to 80 weight %, and more preferably 2 to 50 weight %.

The liquid crystal composition of the present invention showing a chiral smectic C phase comprises at least one compound represented by Formula (1) and further contains as an optically active compound, at least one of known optically active liquid crystal compounds such as optically active phenylbenzoate series liquid crystal compounds, optically active biphenylbenzoate series liquid crystal compounds, optically active naphthalene series liquid crystal compounds, optically active phenylnaphthalene series liquid crystal compounds, optically active phenylpyrimidine series liquid crystal compounds, optically active naphthylpyrimidine series liquid crystal compounds and optically active tolan series liquid crystal compounds.

The content of at least one compound represented by Formula (1) in the compositions showing chiral smectic C phases shall not specifically be restricted and is usually 1 to 99 weight %, preferably 2 to 80 weight %, and more preferably 2 to 50 weight %.

Further, in addition to the essential components described above, the liquid crystal composition of the present invention may contain, as an optional component, a compound showing no liquid crystallinity other than the naphthalene compound of the present invention (for example, dichromatic pigments such as anthraquinone pigments and azo pigments, electroconductivity-providing agents, and life improving agents).

The use of the liquid crystal composition of the present invention can provide a liquid crystal element improved in characteristics such as high speed response, temperature dependency of a response time, orientation, a memory property, and contrast ratio.

The liquid crystal element of the present invention means a liquid crystal element using a liquid crystal composition containing at least one naphthalene compound represented by Formula (1). The liquid crystal element shall not specifically be restricted and relates preferably to a smectic liquid crystal element, more preferably to a ferroelectric liquid crystal element.

The liquid crystal compositions showing ferroelectricity cause a switching phenomenon by applying voltage, and liquid crystal elements having a shorter response time can be prepared by making use of the phenomenon [for example, Japanese Patent Application Laid-Open No. 56-107216 (1981), Japanese Patent Application Laid-Open No. 59-118744 (1984), and Appl. Phys. Lett., 36 899 (1980)].

Next, the liquid crystal element of the present invention shall be explained.

The liquid crystal element of the present invention comprises the liquid crystal composition of the present invention disposed between a pair of electrode substrates to form a liquid crystal layer. In general, the liquid crystal layer can be formed by heating the liquid crystal composition under vacuum until it becomes an isotropic solution, injecting it into a liquid crystal cell, then cooling it to form a liquid crystal layer, and restoring pressure in the system to atmospheric pressure.

Shown in Fig. 1 is a schematic, cross-sectional view showing one example of the liquid crystal elements having a chiral smectic phase for explaining the structure of the liquid crystal element making use of ferroelectricity.

The liquid crystal element shown in Fig. 1 is a transmitting type liquid crystal element. As a matter of course, the form of the liquid crystal element of the present invention shall not specifically be restricted and includes not only a transmitting type liquid crystal element but also, for example, a reflecting type liquid crystal element.

In Fig. 1, 1 represents a liquid crystal (chiral smectic) layer; 2 represents a substrate; 3 represents a transparent electrode; 4 represents an insulating orientation controlling layer; 5 represents a spacer; 6 represents a lead wire; 7 represents a power source; 8 represents a polarizing plate; 9 represents a light source; I_0 represents incident light; and I represents transmitted light.

The liquid crystal element comprises a liquid crystal layer 1 showing a chiral smectic phase disposed between a pair of substrates 2 each of which is provided with a transparent electrode 3 and an insulating orientation controlling layer 4, wherein the layer thickness thereof is controlled by spacers 5, and a power source 7 is connected to a pair of the transparent electrodes 3 via lead wires 6 so that voltage can be applied between the transparent electrodes 3.

Further, a pair of the substrates 2 are interposed between a pair of polarizing plates 8 disposed in a cross-nicol state, and a light source 9 is disposed on one outside thereof.

In general, a glass substrate or a plastic substrate is used for the substrate 2.

The transparent electrodes 3 disposed on two sheets of the substrates 2 include, for example, transparent electrodes comprising thin films of In_2O_3 , SnO_2 and ITO (indium tin oxide).

The insulating orientation controlling layers 4, which are prepared by rubbing a thin films of polymers such as polyimide with gauze or acetate cloth, are for orienting liquid crystal. The materials for the insulating orientation controlling layer 4 include, for example, inorganic materials such as silicon nitride, silicon nitride containing hydrogen, silicon carbide, silicon carbide containing hydrogen, silicon oxide, boron nitride, boron nitride containing hydrogen, cerium oxide, aluminum oxide, zirconium oxide, titanium oxide and magnesium fluoride, and organic materials such as, for example, polyvinyl alcohol, polyimide, polyamideimide, polyesterimide, polyparaxylene, polyester, polycarbonate, polyvinylacetal, polyvinyl chloride, polyvinyl acetate, polyamide, polystyrene, cellulose resins, melamine resins, urea resins, acrylic resins and photoresist resins. Further, the insulating orientation controlling layer 4 may be of a dual layer structure in which an organic insulating layer is formed on an inorganic insulating layer, or a structure comprising only the inorganic insulating layer or the organic insulating layer.

When the insulating orientation controlling layer comprises an inorganic insulating layer, it can be formed by deposition. When it comprises an organic insulating layer, it can be formed by applying a solution dissolving a precursor thereof by spinner coating, dip coating, screen printing, spray coating or roll coating and then curing a resulting film on prescribed curing conditions (for example, heating).

The layer thickness of the insulating orientation controlling layer 4 shall not specifically be restricted and is usually a 1 nm to 10 μm , preferably 1 to 300 nm, more preferably 1 to 100 nm.

Two sheets of the substrates 2 are maintained at an optional space with the spacer 5. The substrates can be maintained at an optional space by interposing, for example, silica beads or alumina beads each having a prescribed diameter as the spacer between the substrates 2 and sealing the circumference thereof with sealant (for example, epoxy adhesives). Further, polymer films and glass fibers may be used as the spacers.

Liquid crystal showing a chiral smectic phase is charged between two sheets of the substrates. The liquid crystal layer 1 is controlled usually to a thickness of 0.5 to 20 μm , preferably 1 to 5 μm .

A display system of the liquid crystal element using the liquid crystal composition of the present invention shall not

specifically be restricted, and there can be used, for example, display systems of (a) helical distortion type, (b) SSFLC (surface stabilized ferroelectric liquid crystal) type, (c) TSM (transient scattering mode) type and (d) G-H (guest-host) type.

The naphthalene compound of the present invention and the liquid crystal composition containing said compound are applicable as well to fields other than liquid crystal elements for display (for example, (1) non-linear photofunctional element, (2) electronics materials such as a condenser material, (3) electronics elements such as a limiter, a memory, an amplifier and a modulator, (4) voltage sensing elements and sensors for heat, light, pressure and mechanical deformation, and (5) power generating elements such as thermoelectric generating element).

EXAMPLES

The present invention shall be explained in further detail with reference to examples, but the present invention shall not be restricted to them. The determination of the phase transition temperatures and the identification of the liquid crystal phases in the examples were carried out by observation under a polarizing microscope equipped with a temperature controller.

Symbols shown in the examples and tables mean the following:

I : isotropic liquid
 N : nematic phase
 S_A : smectic A phase
 Sc : smectic C phase
 Sc* : chiral smectic C phase
 C : crystal phase

In Table 2, the mark "•" means the presence of the liquid crystal phase, and the mark "-" means the absence of the liquid crystal phase. Numerals in parentheses in Table 2 mean temperatures in a step of lowering temperature.

Production Example 1: production of n-butyl 2-hydroxy-6-naphthoate

The mixture of 2-hydroxy-6-naphthoic acid of 18.8 g, N,N-dimethylformamide of 150 g and anhydrous sodium carbonate of 13.3 g was heated to 70°C, and n-butyl bromide of 16.4 g was dropwise added thereto in one hour. After finishing dropwise adding, the suspension was further stirred at 70 to 80°C for 6 hours. The reaction mixture was cooled down to room temperature and filtrated off the inorganic salt. Then the filtrate was discharged into water of 1000 g. The deposited solid was separated, and sludging was carried out in n-hexane, whereby n-butyl 2-hydroxy-6-naphthoate of 22.0 g was obtained in the form of brown crystal.
 Melting point: 107.0 to 112.0°C.

Production Example 2: production of n-pentyl 2-hydroxy-6-naphthoate

The same procedure as described in Production Example 1 was repeated, except that n-pentyl bromide of 18.1 g was substituted for n-butyl bromide in Production Example 1, whereby n-pentyl 2-hydroxy-6-naphthoate of 23.7 g was obtained in the form of brown crystal.
 Melting point: 89.0 to 93.0°C.

Production Example 3: production of n-hexyl 2-hydroxy-6-naphthoate

The same procedure as described in Production Example 1 was repeated, except that n-hexyl bromide of 19.8 g was substituted for n-butyl bromide in Production Example 1, whereby n-hexyl 2-hydroxy-6-naphthoate of 23.9 g was obtained in the form of brown crystal.
 Melting point: 93.0 to 98.0°C.

Production Example 4: production of n-octyl 2-hydroxy-6-naphthoate

The same procedure as described in Production Example 1 was repeated, except that n-octyl bromide 23.2 g was substituted for n-butyl bromide in Production Example 1, whereby n-octyl 2-hydroxy-6-naphthoate of 27.0 g was obtained in the form of brown crystal.
 Melting point: 82.0 to 86.0°C.

Production Example 5: production of n-decyl 2-hydroxy-6-naphthoate

The same procedure as described in Production Example 1 was repeated, except that n-decyl bromide 26.5 g was substituted for n-butyl bromide in Production Example 1, whereby n-decyl 2-hydroxy-6-naphthoate of 30.2 g was obtained in the form of brown crystal.

Melting point: 92.0 to 96.0°C.

Example 1: production of 1'-methylethyl 2-benzyloxy-6-naphthoate

Heated for refluxing were 2-benzyloxy-6-naphthoic acid of 27.8 g and oxalyl chloride of 15.2 g in toluene of 200 g for 3 hours, and then excess oxalyl chloride and toluene were distilled off under reduced pressure to obtain 2-benzyloxy-6-naphthoyl chloride. This acid chloride was dissolved in toluene of 120 g, and pyridine of 9.5 g and 2-propanol of 6.6 g were added thereto, followed by stirring the solution at 80°C for 3 hours. Then, after filtering off deposited pyridine hydrochloride, an organic layer was washed with 1N-hydrochloric acid and further washed with water to neutral. The organic layer was separated, and toluene was distilled off under reduced pressure to obtain a crude product. The product was recrystallized from ethanol, whereby 1'-methylethyl 2-benzyloxy-6-naphthoate of 27.2 g was obtained in the form of colorless crystal.

Melting point: 89.0 to 96.0 g.

Example 2: production of 2'-methylpropyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 2-methyl-1-propanol of 8.1 g was substituted for 2-propanol in Example 1, whereby 2'-methylpropyl 2-benzyloxy-6-naphthoate of 30.1 g was obtained in the form of colorless crystal.

Melting point: 114.0 to 115.5°C.

Example 3: production of 3'-methylbutyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 3-methyl-1-butanol of 9.7 g was substituted for 2-propanol in Example 1, whereby 3'-methylbutyl 2-benzyloxy-6-naphthoate of 31.0 g was obtained in the form of colorless crystal.

Melting point: 89.5 to 91.0°C.

Example 4: production of 4'-methylpentyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 4-methyl-1-pentanol of 11.2 g was substituted for 2-propanol in Example 1, whereby 4'-methylpentyl 2-benzyloxy-6-naphthoate of 29.0 g was obtained in the form of colorless crystal.

Melting point: 64.0 to 67.0°C.

Example 5: production of 1'-ethylpropyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 3-pentanol of 9.7 g was substituted for 2-propanol in Example 1, whereby 1'-ethylpropyl 2-benzyloxy-6-naphthoate of 26.1 g was obtained in the form of colorless crystal.

Melting point: 65.0 to 70.0°C.

Example 6: production of 2'-ethylbutyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 2-ethyl-1-butanol of 11.2 g was substituted for 2-propanol in Example 1, whereby 2'-ethylbutyl 2-benzyloxy-6-naphthoate of 31.7 g was obtained in the form of colorless crystal.

Melting point: 84.0 to 86.0°C.

Example 7: production of 1',1',5'-trihydroperfluoro-n-pentyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 1,1,5-trihydroperfluoro-n-pentyl alcohol of 25.5 g was substituted for 2-propanol in Example 1, whereby 1',1',5'-trihydroperfluoro-n-pentyl 2-benzyloxy-6-naph-

thoate of 38.4 g was obtained in the form of colorless crystal.
Melting point: 98.0 to 100.0°C.

Example 8: production of 1',1',7'-trihydroperfluoro-n-heptyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 1,1,7-trihydroperfluoro-n-heptyl alcohol of 36.5 g was substituted for 2-propanol in Example 1, whereby 1',1',7'-trihydroperfluoro-n-heptyl 2-benzyloxy-6-naphthoate of 39.4 g was obtained in the form of colorless crystal.
Melting point: 108.0 to 112.0°C.

Example 9: production of 2'-(perfluoro-n-butyl)ethyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 2-(perfluoro-n-butyl)ethanol of 51.6 g was substituted for 2-propanol in Example 1, whereby 2'-(perfluoro-n-butyl)ethyl 2-benzyloxy-6-naphthoate of 63.4 g was obtained in the form of colorless crystal.
Melting point: 108.0 to 109.0°C.

Example 10: production of 2'-(perfluoro-n-hexyl)ethyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 1 was repeated, except that 2-(perfluoro-n-hexyl)ethanol of 40.0 g was substituted for 2-propanol in Example 1, whereby 2'-(perfluoro-n-hexyl)ethyl 2-benzyloxy-6-naphthoate of 52.4 g was obtained in the form of colorless crystal.
Melting point: 115.0 to 117.0°C.

Example 11: production of 2'-n-butoxyethyl 2-benzyloxy-6-naphthoate

The mixture of 2-benzyloxy-6-naphthoic acid of 27.8 g, N,N-dimethylformamide of 150 g and anhydrous potassium carbonate of 13.8 g was heated to 80°C, and 2-n-butoxyethyl p-toluenesulfonate of 40.8 g was dropwise added thereto in one hour. After finishing dropwise adding, the suspension was further stirred at 70 - 80°C for 8 hours. After the reaction mixture was cooled down to room temperature, and the inorganic salt was filtered off. Then the filtrate was neutralized with hydrochloric acid and extracted with toluene. A toluene layer was washed with water, and then toluene was distilled off under reduced pressure, whereby 2-n-butoxyethyl 2-benzyloxy-6-naphthoate of 24.6 g was obtained in the form of colorless crystal.
Melting point: 57.0 to 58.0°C.

Example 12: production of 2'-n-hexyloxyethyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 11 was repeated, except that 2-n-hexyloxyethyl p-toluenesulfonate of 45.0 g was substituted for 2-n-butoxyethyl p-toluenesulfonate in Example 11, whereby 2'-n-hexyloxyethyl 2-benzyloxy-6-naphthoate of 28.4 g was obtained in the form of colorless oily substance.

Example 13: production of 2'-(2"-n-hexyloxyethoxy)ethyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 11 was repeated, except that 2-(2'-n-hexyloxyethoxy)ethyl p-toluenesulfonate of 51.6 g was substituted for 2-n-butoxyethyl p-toluenesulfonate in Example 11, whereby 2'-(2"-n-hexyloxyethoxy)ethyl 2-benzyloxy-6-naphthoate of 29.3 g was obtained in the form of colorless oily substance.

Example 14: production of 2'-[2"-(2"-n-butoxyethoxy)ethoxy]ethyl 2-benzyloxy-6-naphthoate

The same procedure as described in Example 11 was repeated, except that 2-[2'-(2"-n-butoxyethoxy)ethoxy]ethyl p-toluenesulfonate of 54.0 g was substituted for 2-n-butoxyethyl p-toluenesulfonate in Example 11, whereby 2'-[2"-(2"-n-butoxyethoxy)ethoxy]ethyl 2-benzyloxy-6-naphthoate of 35.6 g was obtained in the form of colorless oily substance.

Example 15: production of 1'-methylethyl 2-hydroxy-6-naphthoate

1'-methylethyl 2-benzyloxy-6-naphthoate of 16.0 g was dissolved in 2-propanol of 100 g and hydrogenated at 40°C in a hydrogen atmosphere at atmospheric pressure in the presence of 5 weight % Pd/C of 1 g. Pd/C was filtered off, and then 2-propanol was distilled off under reduced pressure, whereby 1'-methylethyl 2-hydroxy-6-naphthoate of 10.2

g was obtained in the form of colorless crystal.
Melting point: 110.0 to 114.0°C.

Example 16: production of 2'-methylpropyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-methylpropyl 2-benzyloxy-6-naphthoate of 16.7 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-methylpropyl 2-hydroxy-6-naphthoate of 10.7 g was obtained in the form of colorless crystal.
Melting point: 112.5 to 123.5°C.

Example 17: production of 3'-methylbutyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 3'-methylbutyl 2-benzyloxy-6-naphthoate of 17.4 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 3'-methylbutyl 2-hydroxy-6-naphthoate of 12.3 g was obtained in the form of colorless crystal.
Melting point: 119.5 to 121.5°C.

Example 18: production of 4'-methylpentyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 4'-methylpentyl 2-benzyloxy-6-naphthoate of 18.1 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 4'-methylpentyl 2-hydroxy-6-naphthoate of 11.6 g was obtained in the form of colorless crystal.
Melting point: 73.0 to 74.5°C.

Example 19: production of 1'-ethylpropyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 1'-ethylpropyl 2-benzyloxy-6-naphthoate of 17.4 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 1'-ethylpropyl 2-hydroxy-6-naphthoate of 11.6 g was obtained in the form of colorless crystal.
Melting point: 89.0 to 92.0°C.

Example 20: production of 2'-ethylbutyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-ethylbutyl 2-benzyloxy-6-naphthoate of 18.1 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-ethylbutyl 2-hydroxy-6-naphthoate of 12.8 g was obtained in the form of colorless crystal.
Melting point: 96.5 to 97.5°C.

Example 21: production of 1',1',5'-trihydroperfluoro-n-pentyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 1',1',5'-trihydroperfluoro-n-pentyl 2-benzyloxy-6-naphthoate of 24.6 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 1',1',5'-trihydroperfluoro-n-pentyl 2-hydroxy-6-naphthoate of 17.5 g was obtained in the form of colorless crystal.
Melting point: 105.0 to 113.0°C.

Example 22: production of 1',1',7'-trihydroperfluoro-n-heptyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 1',1',7'-trihydroperfluoro-n-heptyl 2-benzyloxy-6-naphthoate of 29.6 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 1',1',7'-trihydroperfluoro-n-heptyl 2-hydroxy-6-naphthoate of 20.1 g was obtained in the form of colorless crystal.
Melting point: 123.0 to 132.0°C.

Example 23: production of 2'-(perfluoro-n-butyl)ethyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-(perfluoro-n-butyl)ethyl 2-benzyloxy-6-naphthoate of 26.2 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-(per-

fluoro-n-butyl)ethyl 2-hydroxy-6-naphthoate of 18.6 g was obtained in the form of colorless crystal.
Melting point: 101.0 to 103.0°C.

Example 24: production of 2'-(perfluoro-n-hexyl)ethyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-(perfluoro-n-hexyl)ethyl 2-benzyloxy-6-naphthoate of 31.2 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-(perfluoro-n-hexyl)ethyl 2-hydroxy-6-naphthoate of 21.4 g was obtained in the form of colorless crystal.
Melting point: 124.0 to 127.0°C.

Example 25: production of 2'-n-butoxyethyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-n-butoxyethyl 2-benzyloxy-6-naphthoate of 18.9 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-n-butoxyethyl 2-hydroxy-6-naphthoate of 13.7 g was obtained in the form of colorless crystal.
Melting point: 54.0 to 56.0°C.

Example 26: production of 2'-n-hexyloxyethyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-n-hexyloxyethyl 2-benzyloxy-6-naphthoate of 20.3 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-n-hexyloxyethyl 2-hydroxy-6-naphthoate of 15.0 g was obtained in the form of colorless crystal.
Melting point: 67.0 to 68.0°C.

Example 27: production of 2'-(2"-n-hexyloxyethoxy)ethyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-(2"-n-hexyloxyethoxy)ethyl 2-benzyloxy-6-naphthoate of 22.5 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-(2"-n-hexyloxyethoxy)ethyl 2-hydroxy-6-naphthoate of 15.3 g was obtained in the form of colorless crystal.
Melting point: 59.0 to 62.0°C.

Example 28: production of 2'-[2"-(2'''-n-butoxyethoxy)ethoxy]ethyl 2-hydroxy-6-naphthoate

The same procedure as described in Example 15 was repeated, except that 2'-[2"-(2'''-n-butoxyethoxy)ethoxy]ethyl 2-benzyloxy-6-naphthoate of 23.3 g was substituted for 1'-methylethyl 2-benzyloxy-6-naphthoate in Example 15, whereby 2'-[2"-(2'''-n-butoxyethoxy)ethoxy]ethyl 2-hydroxy-6-naphthoate of 14.2 g was obtained in the form of colorless oily substance.

Example 29: production of Exemplified Compound 15

Dissolved in chloroform of 5 g were 1'-methylethyl 2-hydroxy-6-naphthoate of 230 mg, 4-n-decyloxybenzoic acid of 278 mg, N,N'-dicyclohexylcarbodiimide of 247 mg and 4-pyrrolidinopyridine of 7 mg, and the solution was stirred at room temperature for 24 hours. By-produced N,N'-dicyclohexylurea was filtered off, and then chloroform was distilled off under reduced pressure to obtain a crude product. The crude product was refined with silica gel column chromatography (eluent: toluene) and further recrystallized twice from ethanol/ethyl acetate, whereby the intended product of 392 mg was obtained in the form of colorless crystal.

The phase transition temperatures of this compound are shown in Table 2.

Examples 30 to 114:

The naphthalene compounds were produced in the same manner as described in Example 29, except that 2-hydroxy-6-naphthoic acid esters represented by Formula (3a) and various carboxylic acids represented by Formula (4), each shown in Table 1, were used.

The phase transition temperatures of these compounds are shown in Table 2.

Table 1

Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
29	$n-C_{10}H_{21}O-COOH$ 	
30	$n-C_{12}H_{25}O-COOH$ 	
31	$n-C_{10}H_{21}O-COOH$ 	
32	$n-C_8H_{17}O-COOH$ 	
33	$n-C_9H_{19}O-COOH$ 	
34	$n-C_{10}H_{21}O-COOH$ 	
35	$n-C_{11}H_{23}O-COOH$ 	

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
36	$n-C_{12}H_{25}O-$	
37	$n-C_8H_{13}-$	
38	$n-C_{10}H_{21}O-$	
39	$n-C_8H_{13}-$	
40	$n-C_8H_{17}O-$	
41	$n-C_9H_{19}O-$	
42	$n-C_{10}H_{21}O-$	

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
43	$n-C_{11}H_{23}O-COOH$ 	
44	$n-C_{12}H_{25}O-COOH$ 	
45	$n-C_{10}H_{21}O-COOH$ 	
46	$n-C_6H_{13}-COOH$ 	
47	$n-C_{10}H_{21}O-COOH$ 	
48	$n-C_{12}H_{25}O-COOH$ 	
49	$n-C_8H_{17}O-COOH$ 	

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-\left(\text{O}\right)_z-\text{A}-\text{COOH}$	
50	$n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
51	$n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
52	$n\text{-C}_{11}\text{H}_{23}\text{O}-\text{F}-\text{C}_6\text{H}_3-\text{COOH}$	
53	$n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
54	$n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
55	$n\text{-C}_6\text{H}_{13}-\text{C}_6\text{H}_4-\text{COOH}$	
56	$n\text{-C}_{10}\text{H}_{21}\text{O}-\text{F}-\text{C}_6\text{H}_3-\text{COOH}$	

Table 1 continued

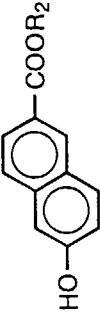
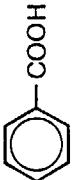
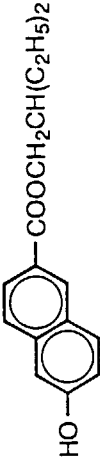
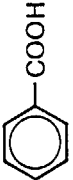
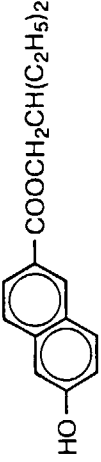
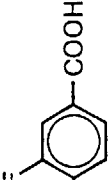
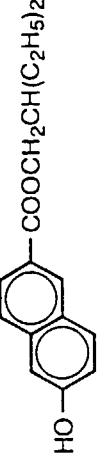
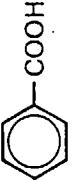
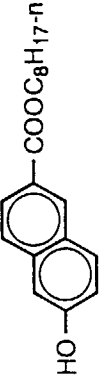
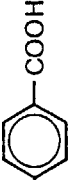
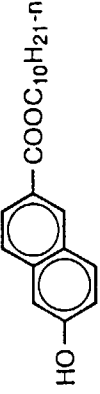
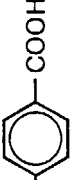
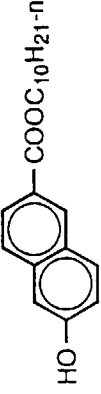
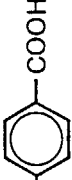
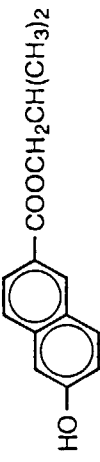
Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
57	$n-C_{10}H_{21}O-COOH$ 	
58	$n-C_{12}H_{25}O-COOH$ 	
59	$n-C_{10}H_{21}O-COOH$ 	
60	$n-C_8H_{17}O-COOH$ 	
61	$n-C_8H_{17}O-COOH$ 	
62	$n-C_{10}H_{21}O-COOH$ 	
63	$H(CF_2)_4CH_2O-COOH$ 	

Table 1 continued

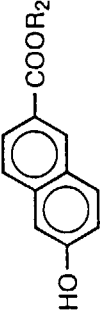
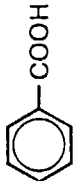
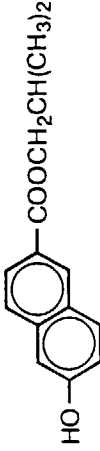
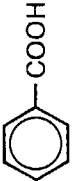
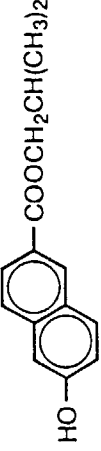
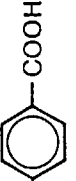
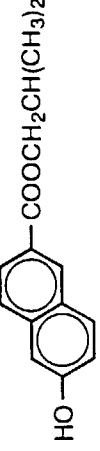
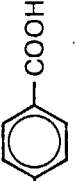
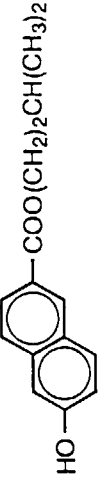
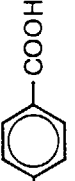
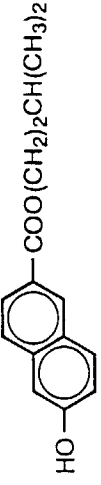
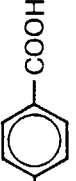
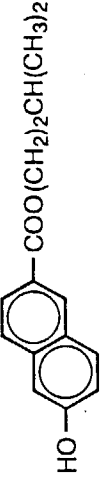
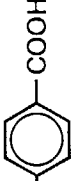
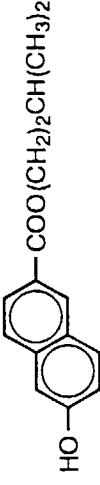
Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
64	$H(CF_2)_8CH_2O-$ 	
65	$H(CF_2)_8CH_2O-$ 	
66	$F(CF_2)_8(CH_2)_3O-$ 	
67	$H(CF_2)_4CH_2O-$ 	
68	$H(CF_2)_6CH_2O-$ 	
69	$H(CF_2)_8CH_2O-$ 	
70	$F(CF_2)_8(CH_2)_3O-$ 	

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
71	$n-C_8H_{17}O-$	
72	$n-C_{10}H_{21}O-$	
73	$n-C_{12}H_{25}O-$	
74	$n-C_8H_{17}O-$	
75	$n-C_{10}H_{21}O-$	
76	$n-C_{12}H_{25}O-$	
77	$n-C_8H_{17}O-$	

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
78	$n-C_9H_{19}O-$	
79	$n-C_{10}H_{21}O-$	
80	$n-C_{11}H_{23}O-$	
81	$n-C_{12}H_{25}O-$	
82	$n-C_8H_{17}O-$	
83	$n-C_{10}H_{21}O-$	
84	$n-C_{12}H_{25}O-$	

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-\text{O}-\text{A}-\text{COOH}$	
85	$\text{H}(\text{CF}_2)_8\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
86	$\text{H}(\text{CF}_2)_8\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
87	$n\text{-C}_6\text{H}_{13}\text{OCH}_2\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
88	$n\text{-C}_6\text{H}_{13}\text{OCH}_2\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
89	$n\text{-C}_6\text{H}_{13}(\text{OCH}_2\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
90	$n\text{-C}_6\text{H}_{13}\text{OCH}_2\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	
91	$n\text{-C}_6\text{H}_{13}\text{OCH}_2\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	

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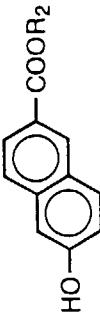
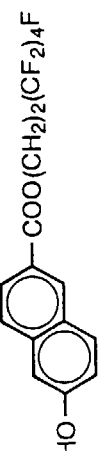
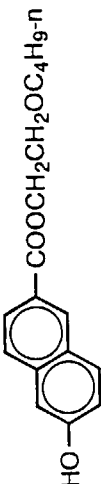
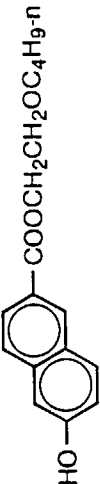
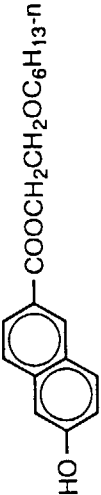
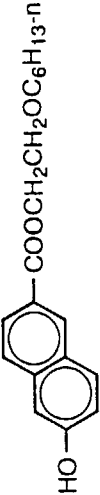
Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
92	$n-C_6H_{13}(OCH_2CH_2)_2O-C_6H_4-COOH$	
93	$n-C_{10}H_{21}O-C_6H_4-COOH$	
94	$n-C_{12}H_{25}O-C_6H_4-COOH$	
95	$n-C_{10}H_{21}O-C_6H_4-COOH$	
96	$n-C_{12}H_{25}O-C_6H_4-COOH$	
97	$n-C_{10}H_{21}O-C_6H_4-COOH$	
98	$n-C_{12}H_{25}O-C_6H_4-COOH$	

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
99		
100		
101		
102		
103		
104		
105		

Table 1 continued

Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
106	$n-C_6H_{13}OCH_2CH_2O-$ 	
107	$n-C_6H_{13}(OCH_2CH_2)_2O-$ 	
108	$n-C_6H_{13}OCH_2CH_2O-$ 	
109	$n-C_6H_{13}(OCH_2CH_2)_2O-$ 	
110	$n-C_{10}H_{21}O-$ 	
111	$n-C_{12}H_{25}O-$ 	
112	$n-C_{12}H_{25}O-$ 	

Table 1 continued

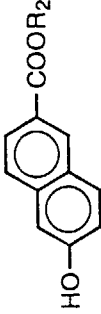
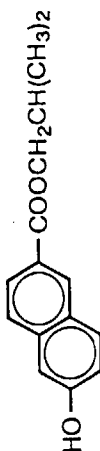
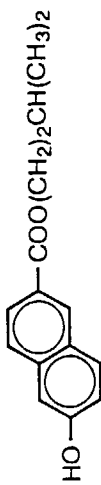
Example No.	Compound (4)	Compound (3a)
	$R_1-(O)_z-A-COOH$	
113	$n-C_{10}H_{21}O-$ 	
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Table 2

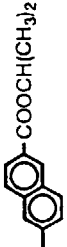
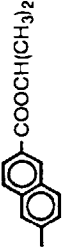
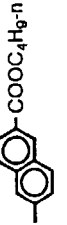
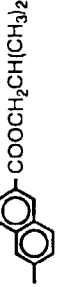
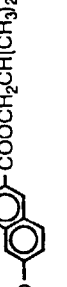
Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
29	15 	• 65	• (60)	• 98	-	•
30	16 	• 73	• (62)	• 97	-	•
31	19 	• 57	• (43)	• 113	-	•
32	27 	• 61	• (48)	• 113	• 118	•
33	28 	• 66	• (62)	• 114	• 116	•
34	29 	• 67	• (64)	• 116	-	•
35	30 	• 79	• (68)	• 115	-	•

Table 2 continued

Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
36	31 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	• 57	• (51)	• 115	-	•
37	33 $n\text{-C}_8\text{H}_{13}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	• 64	• (54)	• 77	-	•
38	35 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_3(\text{F})-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}(\text{CH}_3)_2$	• 83	• (71)	• 106	-	•
39	41 $n\text{-C}_6\text{H}_{13}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOC}_5\text{H}_{11}\text{-}n$	• 64	-	• (57)	• 65	•
40	44 $n\text{-C}_8\text{H}_{17}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$	• 76	-	• 107	-	•
41	45 $n\text{-C}_9\text{H}_{19}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$	• 68	• (52)	• 103	-	•
42	46 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$	• 79	• (66)	• 105	-	•

Table 2 continued

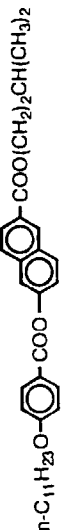
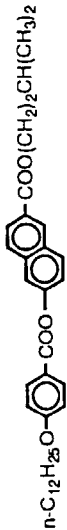
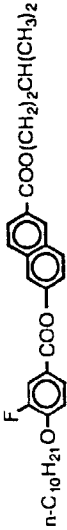
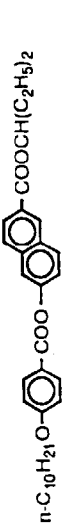
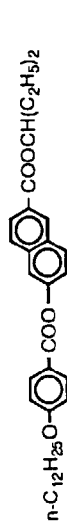
Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
43	47 	•	•	• (74)	• 104	•
44	48 	•	•	• (74)	• 104	•
45	49 	•	•	• (58)	• 96	•
46	50 	•	•	• (38)	• (52)	•
47	51 	•	•	• (41)	• (58)	•
48	52 	•	•	• (38)	• (58)	•
49	55 	•	•	• 74	• 109	•

Table 2 continued

Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
50	56 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOC}_6\text{H}_{13}\text{-}n$	•	76	•	110	•
51	57 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOC}_6\text{H}_{13}\text{-}n$	•	67	•	110	•
52	60 $n\text{-C}_{11}\text{H}_{23}\text{O}-\text{C}_6\text{H}_3(\text{F})-\text{COO}-\text{C}_6\text{H}_4-\text{COOC}_6\text{H}_{13}\text{-}n$	•	87	•	99	•
53	62 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_3\text{CH}(\text{CH}_3)_2$	•	64	•	105	•
54	63 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_3\text{CH}(\text{CH}_3)_2$	•	71	•	104	•
55	65 $n\text{-C}_6\text{H}_{13}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_3\text{CH}(\text{CH}_3)_2$	•	69	•	(53)	(55)
56	66 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_3(\text{F})-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_3\text{CH}(\text{CH}_3)_2$	•	75	•	(72)	94

Table 2 continued

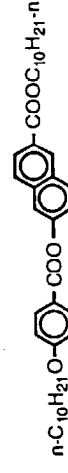
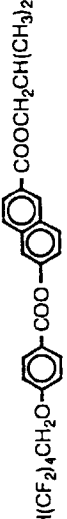
Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
57	67 	•	•	•	78	•
58	68 	•	•	•	(78)	•
59	72 	•	•	•	67	•
60	86 	•	•	•	108	•
61	106 	•	•	•	105	•
62	107 	•	•	•	107	•
63	148 	•	•	•	127	•

Table 2 continued

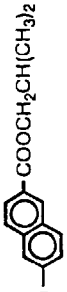
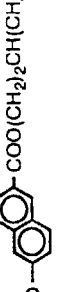
Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
64	149 $\text{H}(\text{CF}_2)_6\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}(\text{CH}_3)_2$ 	•	96	• (88)	• 148	•
65	150 $\text{H}(\text{CF}_2)_8\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}(\text{CH}_3)_2$ 	•	103	•	• 170	•
66	152 $\text{F}(\text{CF}_2)_8(\text{CH}_2)_3\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}(\text{CH}_3)_2$ 	•	112	• (111)	• 228	•
67	161 $\text{H}(\text{CF}_2)_4\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$ 	•	80	• (76)	• 99	•
68	162 $\text{H}(\text{CF}_2)_6\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$ 	•	81	• (78)	• 115	•
69	163 $\text{H}(\text{CF}_2)_8\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$ 	•	102	• (77)	• 138	•
70	164 $\text{F}(\text{CF}_2)_8(\text{CH}_2)_3\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2\text{CH}(\text{CH}_3)_2$ 	•	120	• 140	• 206	•

Table 2 continued

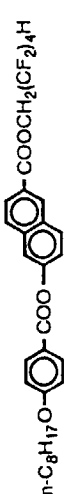
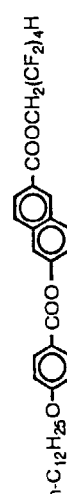
Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
71	185 $n\text{-C}_8\text{H}_{17}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2(\text{CF}_2)_4\text{H}$ 	•	•	•	•	•
72	187 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2(\text{CF}_2)_4\text{H}$ 	•	•	•	•	•
73	188 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2(\text{CF}_2)_4\text{H}$ 	•	•	•	•	•
74	189 $n\text{-C}_8\text{H}_{17}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2(\text{CF}_2)_6\text{H}$ 	•	•	•	•	•
75	190 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2(\text{CF}_2)_6\text{H}$ 	•	•	•	•	•
76	191 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2(\text{CF}_2)_6\text{H}$ 	•	•	•	•	•
77	193 $n\text{-C}_8\text{H}_{17}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2(\text{CF}_2)_4\text{F}$ 	•	•	•	•	•

Table 2 continued

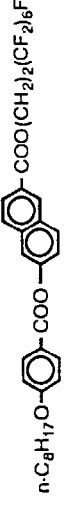
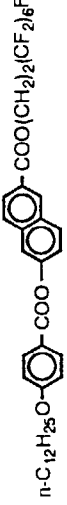
Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
78	194 	• 89	• 138	• 150	-	•
79	195 	• 83	• 137	• 146	-	•
80	196 	• 89	• 134	• 141	-	•
81	197 	• 87	• 130	• 136	-	•
82	202 	• 102	• 150	• 176	-	•
83	203 	• 96	• 151	• 164	-	•
84	204 	• 101	• 146	• 152	-	•

Table 2 continued

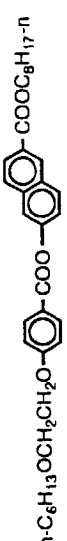
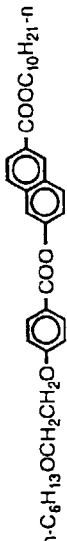
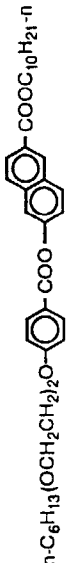
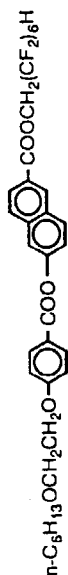
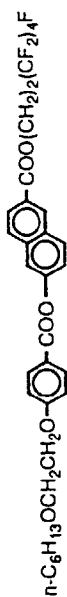
Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
85	207 	• 116	• (92)	• 123	-	•
86	216 	• 116	• 132	• 134	-	•
87	220 	• 52	• (35)	• 57	-	•
88	221 	• 66	-	• (59)	-	•
89	224 	• 48	-	• (36)	-	•
90	232 	• 83	• (72)	• 95	-	•
91	233 	• 74	• 89	• 126	-	•

Table 2 continued

Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
92	236 $n\text{-C}_6\text{H}_{13}(\text{OCH}_2\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2)_2(\text{CF}_2)_4\text{F}$	• 57	• 87	• 115	-	•
93	244 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}_2\text{OC}_4\text{H}_9\text{-n}$	• 71	• (50)	• 88	-	•
94	245 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}_2\text{OC}_4\text{H}_9\text{-n}$	• 71	-	• 90	-	•
95	248 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}_2\text{OC}_6\text{H}_{13}\text{-n}$	• 72	-	• 86	-	•
96	249 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COOCH}_2\text{CH}_2\text{OC}_6\text{H}_{13}\text{-n}$	• 74	-	• 87	-	•
97	257 $n\text{-C}_{10}\text{H}_{21}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2\text{CH}_2\text{O})_2\text{C}_6\text{H}_{13}\text{-n}$	• 60	-	• (57)	-	•
98	258 $n\text{-C}_{12}\text{H}_{25}\text{O}-\text{C}_6\text{H}_4-\text{COO}-\text{C}_6\text{H}_4-\text{COO}(\text{CH}_2\text{CH}_2\text{O})_2\text{C}_6\text{H}_{13}\text{-n}$	• 65	-	• (60)	-	•

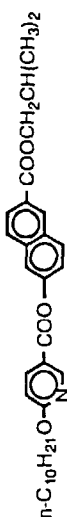
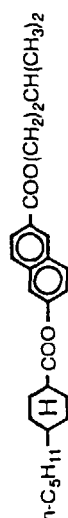
Table 2 continued

Example No.	Exemplified compound No.	Phase transition temperature (°C)					
		C	S _C	S _A	N	I	I
99	306		• 112	• 164	• 243	-	•
100	308		• 105	• 143	• 225	-	•
101	309		• 117	• 186	• 231	-	•
102	310		• 102	• 151	• 218	-	•
103	316		• 117	• 186	• 227	-	•
104	318		• 76	• 162	• 204	-	•
105	323		• 134	• 181	• 212	-	•

Table 2 continued

Example No.	Exemplified compound No.	Phase transition temperature (°C)					
		C	S _C	S _A	N	I	
106	335	•	111	• 139	• 204	-	•
107	340	•	71	• 132	• 180	-	•
108	345	•	74	• 135	• 178	-	•
109	346	•	32	• 111	• 152	-	•
110	363	•	109	• 119	• 170	-	•
111	364	•	91	• 120	• 156	-	•
112	403	•	90	• 116	• 148	-	•

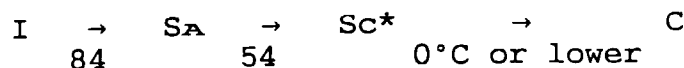
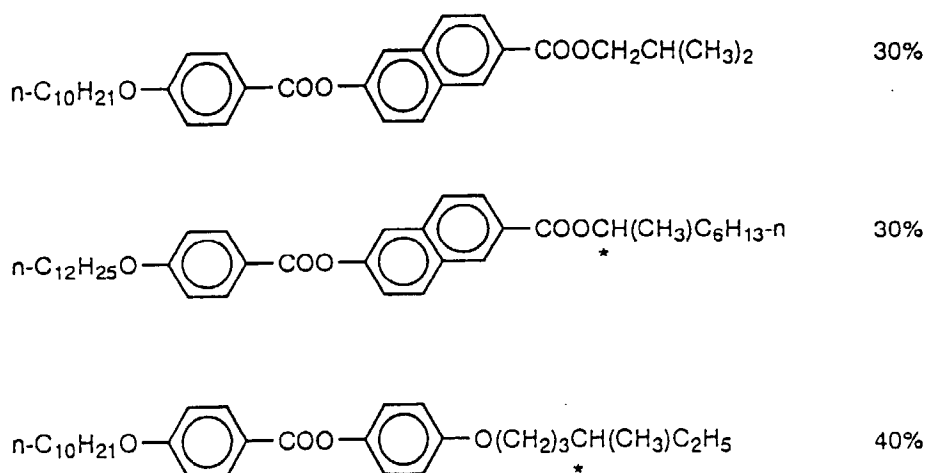
Table 2 continued

Example No.	Exemplified compound No.	Phase transition temperature (°C)				
		C	S _C	S _A	N	I
113	460 	•	111	-	-	•
114	521 	•	88	-	-	•

Example 115: preparation of liquid crystal composition

The following compounds were blended in the ratio shown below and heated at 100°C to be dissolved, whereby a liquid crystal composition A (ferroelectric liquid crystal composition) was prepared. In the formulas, the mark "*" shows optically active carbon.

Phase transition temperatures (°C):

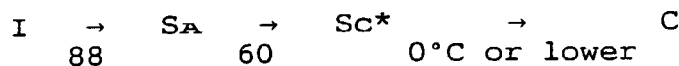
Composition APreparation of liquid crystal element:

Transparent electrodes and insulating orientation controlling layers made of polyimide were provided on two glass plates having a thickness of 0.7 mm, and alumina beads having an average particle diameter of 2 μm were dispersed on one of the glass plates. Then, the glass plates were stuck together with sealant to prepare a cell shown in Fig. 1. This cell was charged with the liquid crystal composition prepared above after heating it to be in an isotropic phase, and the liquid crystal composition was gradually cooled down to be in a ferroelectric liquid crystal phase at a rate of 1°C/minute, whereby a liquid crystal element was prepared. This liquid crystal element was interposed between two polarizing plates disposed in a cross-nicol state, and was applied a voltage of 20 V to detect an optical response (change in a transmitted light quantity: 10 to 90 %), whereby the response time was determined. The measured results are shown in Fig. 2.

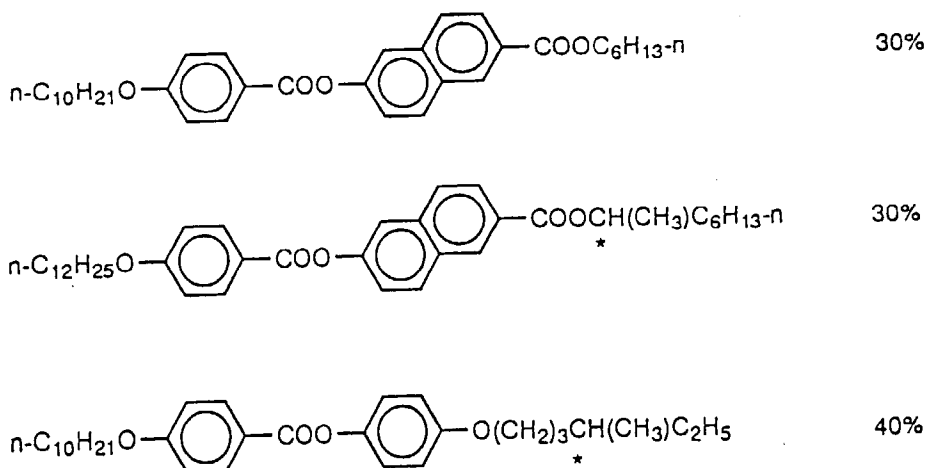
Example 116: preparation of liquid crystal composition

The following compounds were blended in the ratio shown below and heated at 100°C to be dissolved, whereby a liquid crystal composition B (ferroelectric liquid crystal composition) was prepared. In the formulas, the mark "*" shows optically active carbon.

Phase transition temperatures (°C):



Composition B

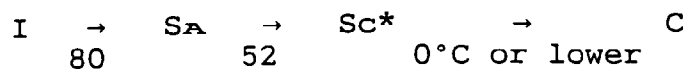
Preparation of liquid crystal element:

Transparent electrodes and insulating orientation controlling layers made of polyimide were provided on two glass plates having a thickness of 0.7 mm, and alumina beads having an average particle diameter of 2 μm were dispersed on one of the glass plates. Then, the glass plates were stuck together with sealant to prepare a cell shown in Fig. 1. This cell was charged with the liquid crystal composition prepared above after heating it to be in an isotropic phase, and the liquid crystal composition was gradually cooled down to be in a ferroelectric liquid crystal phase at a rate of 1°C/minute, whereby a liquid crystal element was prepared. This liquid crystal element was interposed between two polarizing plates disposed in a cross-nicol state, and was applied a voltage of 20 V to detect an optical response (change in a transmitted light quantity: 10 to 90 %), whereby the response time was determined. The measured results are shown in Fig. 2.

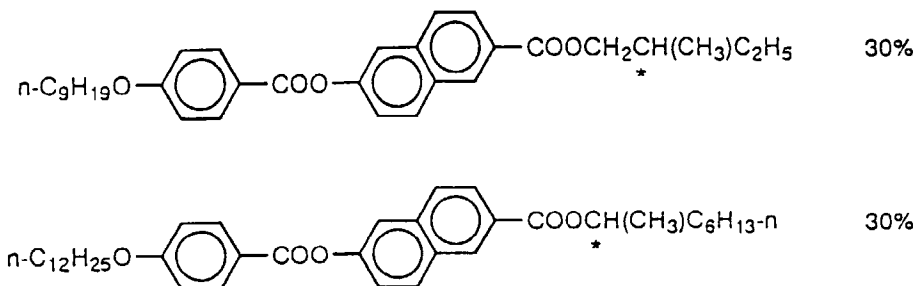
Comparative Example: preparation of liquid crystal composition

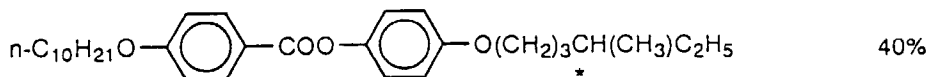
The following compounds were blended in the ratio shown below and heated at 100°C to be dissolved, whereby a liquid crystal composition C (ferroelectric liquid crystal composition) was prepared. In the formulas, the mark "*" shows optically active carbon.

Phase transition temperatures (°C):



Composition C





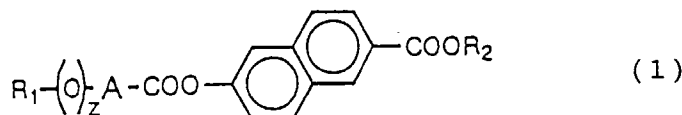
Preparation of liquid crystal element:

Transparent electrodes and insulating orientation controlling layers made of polyimide were provided on two glass plates having a thickness of 0.7 mm, and alumina beads having an average particle diameter of 2 μm were dispersed on one of the glass plates. Then, the glass plates were stuck together with sealant to prepare a cell shown in Fig. 1. This cell was charged with the liquid crystal composition prepared above after heating it to be in an isotropic phase, and the liquid crystal composition was gradually cooled down to be in a ferroelectric liquid crystal phase at a rate of 1°C/minute, whereby a liquid crystal element was prepared. This liquid crystal element was interposed between two polarizing plates disposed in a cross-nicol state, and was applied a voltage of 20 V to detect an optical response (change in a transmitted light quantity: 10 to 90 %), whereby the response time was determined. The measured results are shown in Fig. 2.

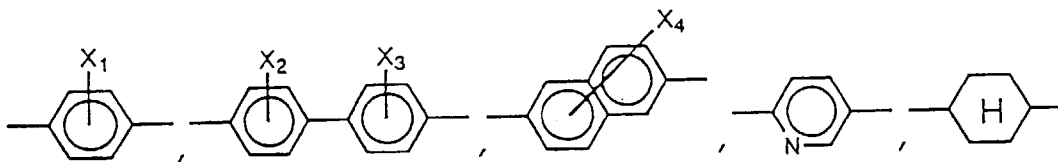
It has been found from the comparison of the examples of the present invention with the comparative example each shown in Fig. 2 that while the response time is 55 μsec at 25°C in the liquid crystal composition C, it is 40 μsec in the liquid crystal compositions A and B and therefore the response time is shortened. With respect to a variation in the response time at 20 - 40°C, while the response time at 20°C is about five times as long as the response time at 40°C in the liquid crystal composition C, a variation in the response time is about four times in the liquid crystal compositions A and B. Accordingly, it can be found that the liquid crystal compositions of the present invention have less temperature dependency of the response time.

Claims

1. A naphthalene compound represented by the following Formula (1):



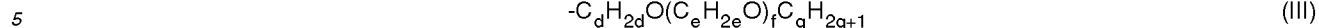
wherein R_1 and R_2 each represent a linear or branched alkyl group having 1 to 20 carbon atoms, an alkoxyalkyl group having 2 to 20 carbon atoms or an alkenyl group having 2 to 20 carbon atoms; each of R_1 and R_2 is optionally substituted with halogen atoms; A represents any of the groups represented by the following formulas:



(wherein X_1 , X_2 , X_3 and X_4 each represent a hydrogen atom or a halogen atom, and 1,4-cyclohexylene ring is disposed in a trans position); and z represents 0 or 1.

2. A naphthalene compound as described in claim 1, wherein R_1 and/or R_2 each are an alkyl group or alkoxyalkyl group represented by Formulas (I), (II) or (III):





(wherein a represents a natural number of 1 to 20; b represents a natural number of 0 to 17; c represents a natural number of 1 to 9; d represents a natural number of 1 to 10; e represents a natural number of 1 to 10; f represents a natural number of 0 to 5; and g represents a natural number of 1 to 12, provided that $b + c \times 2 \leq 19$ and $d + e \times f + g \leq 20$).

3. A naphthalene compound as described in claim 1, wherein R_1 and/or R_2 each are a halogenated alkyl group represented by Formula (IV), (V) or (VI):



wherein X represents a halogen atom; h represents a natural number of 0 to 19; i represents a natural number of 1 to 20; j represents a natural number of 0 to 18; k represents a natural number of 1 to 10; l represents a natural number of 1 to 19; and m represents a natural number of 1 to 19; n represents a natural number of 0 to 19; p represents a natural number of 1 to 20, provided that $h + i \leq 20$, $j + k \times l + m \leq 20$ and $n + p \leq 20$).

4. A naphthalene compound as described in claim 1, wherein either of R_1 and R_2 is a halogenated alkyl group represented by Formula (IV), (V) or (VI):



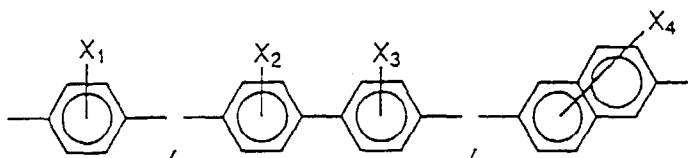
wherein X represents a halogen atom; h represents a natural number of 0 to 19; i represents a natural number of 1 to 20; j represents a natural number of 0 to 18; k represents a natural number of 1 to 10; l represents a natural number of 1 to 19; and m represents a natural number of 1 to 19; n represents a natural number of 0 to 19; p represents a natural number of 1 to 20, provided that $h + i \leq 20$, $j + k \times l + m \leq 20$ and $n + p \leq 20$), and the other is an alkyl group or alkoxyalkyl group represented by Formula (I), (II) or (III):



wherein a represents a natural number of 1 to 20; b represents a natural number of 0 to 17; c represents a natural

number of 1 to 9; d represents a natural number of 1 to 10; e represents a natural number of 1 to 10; f represents a natural number of 0 to 5; and g represents a natural number of 1 to 12, provided that $b + c \times 2 \leq 19$ and $d + e \times f + g \leq 20$.

5. A naphthalene compound as described in any of claims 1 to 4, wherein A is any of the groups represented by the following formulas:

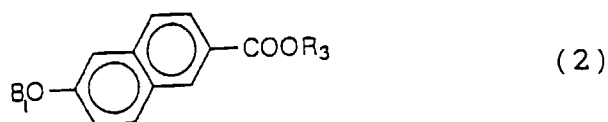


wherein X_1 , X_2 , X_3 and X_4 each represent a hydrogen atom or a halogen atom.

6. A naphthalene compound as described in claim 1 or 5 wherein R_1 is a linear or branched alkyl group having no asymmetric carbon atoms and having 1 to 20 carbon atoms which may be substituted with one or more halogen atoms; R_2 is a branched alkyl group having no asymmetric carbon atoms and having 3 to 20 carbon atoms, or a linear or branched alkyl group having 1 to 20 carbon atoms and may be substituted with one or more halogen atoms and have no asymmetric carbon atoms; and A is a 1,4-phenylene group or a 4,4'-biphenylene group which may be substituted with one or more halogen atoms.

7. A naphthalene compound as described in claim 1, wherein R_1 and R_2 each are a linear alkyl group having 1 to 20 carbon atoms, and A is a 1,4-phenylene group or a 4,4'-biphenylene group.

8. A naphthalene compound represented by the following Formula (2):



wherein R_3 represents a branched alkyl group having no asymmetric carbon atoms and having 3 to 20 carbon atoms, or a linear or branched alkyl group having 1 to 20 carbon atoms, an alkoxyalkyl group having 2 to 20 carbon atoms or an alkenyl group having 2 to 20 carbon atoms which are substituted with halogen atoms and have no asymmetric carbon atoms; and B_1 represents a hydrogen atom or a benzyl group.

9. A liquid crystal composition containing at least one naphthalene compound as described in any of claims 1-7.

10. A liquid crystal element comprising the liquid crystal composition as described in claim 9 disposed between a pair of electrode substrates.

FIG. 1

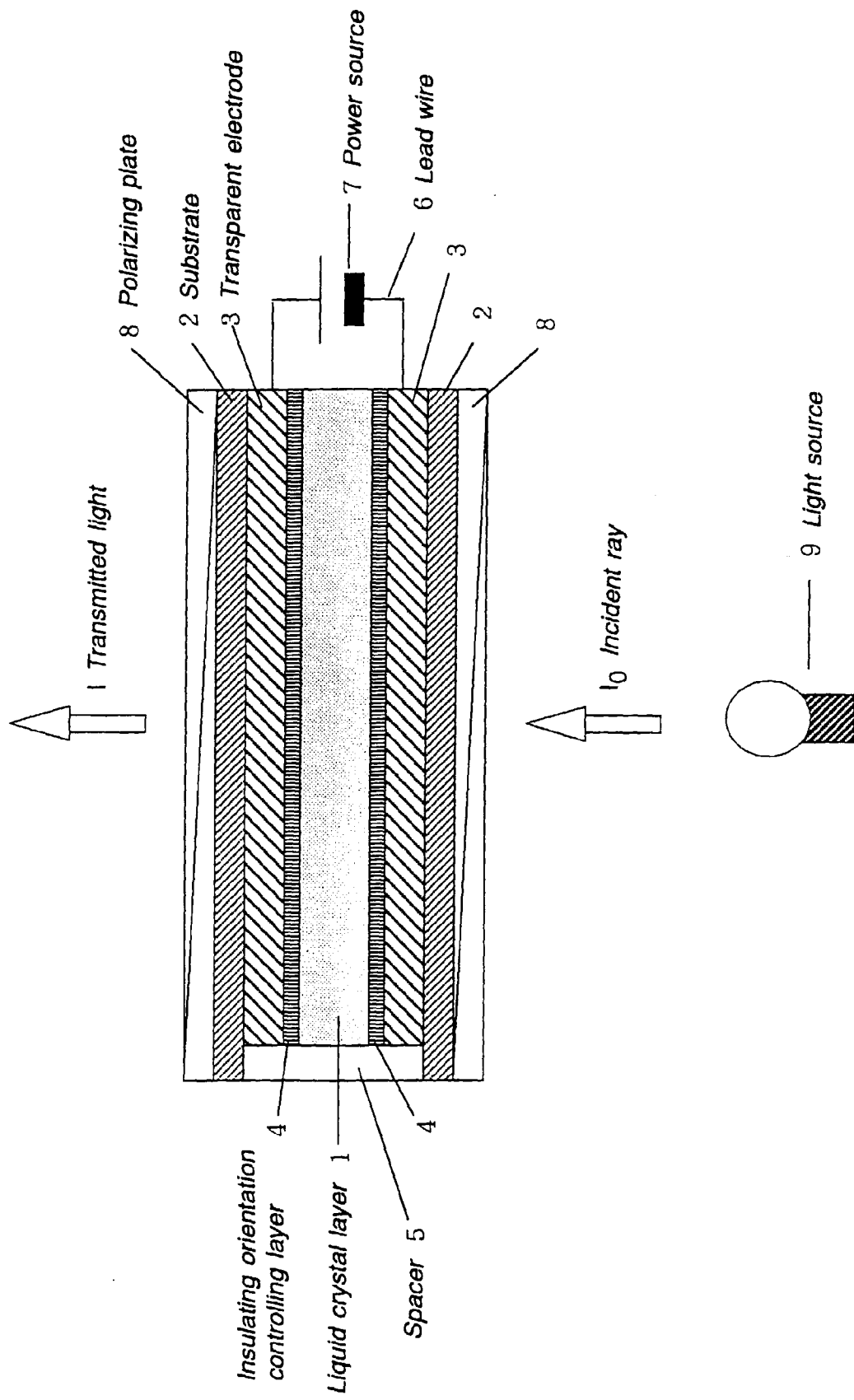


FIG. 2